PTO - 1449 CHECKLIST

Serial No. [illegible]

Examiner: [illegible]

Date to Examiner: [illegible]

For each considered document, both the month a
MUST be provided - no exceptions. Class and subc
MUST either be provided or the space lined throu
Examiners name and the date the disclosure citat
considered **MUST** be provided at the bottom of the PTO

CHECK OFF THE FOLLOWING ITEMS AS COMPL

For each citation considered:

1. ☐ Initials inserted in left-hand column for each citation considere

2. ☐ Month ☐ Year - inserted in appropriate box (if unavailable, incomplete - go to item 4)

3. ☐ Class ☐ Subclass - inserted in appropriate box (if unavailable, still proper, but you **MUST** draw a line through each blank spac

For each citation not considered or incomplete:

4. ☐ Citation lined through if not considered or incomplete

At bottom of PTO 1449:

5. ☐ Examiner's name in appropriate place

6. ☐ Enter the date citations [illegible]

CLAIMS:

1. A direct current motor rotation detecting apparatus configured to detect at least one of a rotational direction, a rotational speed, a rotational position, and a cumulative rotation number of a rotor of a direct current motor, comprising:

at least one rotation detecting brush configured to detect a rotation of the rotor;

a differentiating circuit configured to differentiate a voltage obtained through the at least one rotation detecting brush; and

a pulse generator configured to be triggered by the differentiating circuit at a time interval proportional to a rotational speed of the direct current motor and to generate pulses each having a predetermined pulse width.

2. The direct current motor rotation detecting apparatus according to claim 1, wherein a pulse width of the pulses generated from the pulse generator satisfies condition (1):

(1) $tw < (60/nN)$

where tw is an output pulse width (seconds), n is a number of rotor magnetic poles, and N is a maximum rotational speed (r.p.m) of the direct current motor.

3. A direct current motor rotation control apparatus configured to control at least one of a rotational direction, a rotational speed, a rotational position, and a cumulative rotation number of a rotor of a direct current motor, comprising:

at least one rotation detecting brush configured to detect a rotation of the rotor;

a motor driving circuit configured to apply a direct current drive voltage to a pair of electrode brushes and to drive the direct current motor;

a differentiating circuit configured to differentiate a voltage obtained through the at least one rotation detecting brush;

a pulse generator configured to be triggered by the differentiating circuit at a time interval proportional to a rotational speed of the direct current motor and to generate pulses each having a predetermined pulse width; and

a motor control circuit configured to obtain at least one of a rotational speed and a cumulative rotation number of the rotor based on the pulses generated by the pulse generator and to control the motor driving circuit based on the at least one of the rotational speed and

the cumulative rotation number of the rotor.

4. The direct current motor rotation control apparatus according to claim 3, wherein the motor control circuit comprises:

a pulse interval measuring device configured to measure a pulse interval of output pulses of the pulse generator;

a rotational speed calculating device configured to calculate a rotational speed of the rotor based on the pulse interval measured by the pulse interval measuring device;

a rotational speed comparing device configured to compare the rotational speed of the rotor calculated by the rotational speed calculating device with a target rotational speed of the rotor; and

a chopping control device configured to control a drive output signal of the motor driving circuit by performing chopping control based on a comparison result obtained by the rotational speed comparing device such that the rotational speed of the rotor reaches the target rotational speed.

5. The direct current motor rotation control apparatus according to claim 4, wherein the motor control circuit further comprises:

a rotational speed detection suppressing device configured to invalidate a rotational speed detection result measured by the pulse interval measuring device when a chopping operation is performed by the chopping control device.

6. The direct current motor rotation control apparatus according to claim 3, wherein the motor control circuit comprises:

a pulse number counting device configured to count a pulse number of the output pulses of the pulse generator;

a cumulative rotation number calculating device configured to calculate a cumulative rotation number of the rotor based on the pulse number counted by the pulse number counting device;

a remaining rotation number calculating device configured to calculate a remaining rotation number based on the cumulative rotation number subtracted from a target cumulative rotation number; and

a motor control signal generating device configured to generate and apply motor control signals to the motor driving circuit based on the remaining rotation number calculated by the remaining rotation number calculating device.

7. A direct current motor rotation control apparatus configured to control rotational operations of a direct current motor, comprising:

at least one rotation detecting brush configured to detect a rotation of a rotor;

a motor driving circuit configured to apply a direct current drive voltage to a pair of electrode brushes and to drive the direct current motor;

a differentiating circuit configured to differentiate a voltage obtained through the at least one rotation detecting brush;

a pulse generator configured to be triggered by the differentiating circuit at a time interval proportional to a rotational speed of the direct current motor and to generate pulses each having a predetermined pulse width; and

a motor control circuit configured to adjust the direct current drive voltage based on the pulses generated by the pulse generator, thereby to control an operation of the direct current motor.

8. The direct current motor rotation control apparatus according to claim 7, wherein the motor control circuit comprises:

a pulse interval measuring device configured to measure a pulse interval of output pulses of the pulse generator;

a rotational speed calculating device configured to calculate a rotational speed of the direct current motor based on the pulse interval measured by the pulse interval measuring device;

a rotational speed comparing device configured to compare the rotational speed of the direct current motor calculated by the rotational speed calculating device with a target rotational speed of the direct current motor and to produce a comparison result;

a speed converting device configured to calculate, based on the comparison result, a value of the direct current drive voltage to be applied to the pair of electrode brushes so as to obtain the target rotational speed; and

a drive voltage control device configured to apply a direct current drive voltage to the

pair of electrode brushes corresponding to the value of the direct current drive voltage calculated from the speed converting device.

9. The direct current motor rotation control apparatus according to claim 7, wherein the motor control circuit comprises:

a pulse interval measuring device configured to measure a pulse interval of output pulses of the pulse generator;

a rotational speed calculating device configured to calculate a rotational speed of the direct current motor based on the pulse interval measured by the pulse interval measuring device;

a pulse number counting device configured to count a pulse number of the output pulses of the pulse generator;

a cumulative rotation number calculating device configured to calculate a cumulative rotation number of the direct current motor based on the pulse number counted by the pulse number counting device;

a remaining rotation number calculating device configured to calculate a remaining rotation number based on the cumulative rotation number subtracted from a target cumulative rotation number;

a rotational speed switching device configured to switch a first target rotational speed of the direct current motor to a second target rotational speed corresponding to the remaining rotation number when the remaining rotation number reaches at least a first predetermined remaining rotation number;

a speed converting device configured to calculate a value of the direct current drive voltage to be applied to the pair of electrode brushes based on the rotational speed and the second target rotational speed; and

a drive voltage control device configured to control the drive voltage to the electrode brushes by applying a direct current drive voltage corresponding to the value of voltage calculated by the speed converting device to the motor driving circuit so as to obtain the second target rotational speed of the direct current motor.

10. A direct current motor rotation detecting apparatus configured to detect at least one of a rotational direction, a rotational speed, a rotational position, and a cumulative

rotation number of a rotor of a direct current motor, comprising:

rotation detecting means for detecting a rotation of the rotor;

differentiating means for differentiating a voltage obtained through the rotation detecting means; and

pulse generating means for generating pulses each having a predetermined pulse width at a time interval proportional to a rotational speed of the direct current motor.

11. A direct current motor rotation control apparatus configured to control at least one of a rotational direction, a rotational speed, a rotational position, and a cumulative rotation number of a rotor of a direct current motor, comprising:

rotation detecting means for detecting a rotation of the rotor;

motor driving means for applying a direct current drive voltage to a pair of electrode brushes and for driving the direct current motor;

differentiating means for differentiating a voltage obtained through the rotation detecting means;

pulse generating means for generating pulses each having a predetermined pulse width at a time interval proportional to a rotational speed of the direct current motor; and

motor control means for obtaining at least one of a rotational speed and a cumulative rotation number of the rotor based on the pulses generated by the pulse generating means and for controlling the motor driving means based on the at least one of the rotational speed and the cumulative rotation number.

12. The direct current motor rotation control apparatus according to claim 11, wherein the motor control means comprises:

pulse interval measuring means for measuring a pulse interval of output pulses of the pulse generating means;

rotational speed calculating means for calculating a rotational speed of the rotor based on the pulse interval measured by the pulse interval measuring means;

rotational speed comparing means for comparing the rotational speed of the rotor calculated by the rotational speed calculating means with a target rotational speed of the rotor; and

chopping control means for controlling a drive output signal of the motor driving

means by performing chopping control based on a comparison result obtained by the rotational speed comparing means such that the rotational speed of the rotor reaches the target rotational speed.

13. The direct current motor rotation control apparatus according to claim 12, wherein the motor control means further comprises:

rotational speed detection suppressing means for invalidating a rotational speed detection result measured by the pulse interval measuring means when a chopping operation is performed by the chopping control means.

14. The direct current motor rotation control apparatus according to claim 11, wherein the motor control means comprises:

pulse number counting means for counting a pulse number of the output pulses of the pulse generating means;

cumulative rotation number calculating means for calculating a cumulative rotation number of the rotor based on the pulse number counted by the pulse number counting means;

remaining rotation number calculating means for calculating a remaining rotation number based on the cumulative rotation number subtracted from a target cumulative rotation number; and

motor control signal generating means for generating and applying motor control signals to the motor driving means based on the remaining rotation number calculated by the remaining rotation number calculating means.

15. A direct current motor rotation control apparatus configured to control rotational operations of a direct current motor, comprising:

rotation detecting means for detecting a rotation of the direct current motor;

motor driving means for applying a direct current drive voltage to a pair of electrode brushes and for driving the direct current motor;

differentiating means for differentiating a voltage obtained through the at least one rotation detecting means;

pulse generating means for generating pulses each having a predetermined pulse width at a time interval proportional to a rotational speed of the direct current motor; and

motor control means for adjusting the direct current drive voltage based on the pulses generated by the pulse generating means, for controlling an operation of the direct current motor.

16. The direct current motor rotation control apparatus according to claim 15, wherein the motor control means comprises:

pulse interval measuring means for measuring a pulse interval of output pulses of the pulse generating means;

rotational speed calculating means for calculating a rotational speed of the direct current motor based on the pulse interval measured by the pulse interval measuring means;

rotational speed comparing means for comparing the rotational speed of the direct current motor calculated by the rotational speed calculating means with a target rotational speed of the direct current motor and for producing a comparison result;

speed converting means for calculating, based on the comparison result, a value of the direct current drive voltage to be applied to the pair of electrode brushes for obtaining the target rotational speed; and

drive voltage control means for applying a direct current drive voltage to the pair of electrode brushes corresponding to the value of the direct current drive voltage calculated from the speed converting means.

17. The direct current motor rotation control apparatus according to claim 15, wherein the motor control means comprises:

pulse interval measuring means for measuring a pulse interval of output pulses of the pulse generating means;

rotational speed calculating means for calculating a rotational speed of the direct current motor based on the pulse interval measured by the pulse interval measuring means;

pulse number counting means for counting a pulse number of the output pulses of the pulse generating means;

cumulative rotation number calculating means for calculating a cumulative rotation number of the direct current motor based on the pulse number counted by the pulse number counting means;

remaining rotation number calculating means for calculating a remaining rotation

number based on the cumulative rotation number subtracted from a target cumulative rotation number;

rotational speed switching means for switching a first target rotational speed of the direct current motor to a second target rotational speed corresponding to the remaining rotation number when the remaining rotation number reaches at least a first predetermined remaining rotation number;

speed converting means for calculating a value of the direct current drive voltage to be applied to the pair of electrode brushes based on the rotational speed and the second target rotational speed; and

drive voltage control means for controlling the drive voltage to the electrode brushes by applying a direct current drive voltage corresponding to the value of voltage calculated by the speed converting means to the motor driving means so as to obtain the second target rotational speed of the direct current motor.

18. A method for detecting at least one of a rotational direction, a rotational speed, a rotational position, and a cumulative rotation number of a rotor of a direct current motor, comprising:

detecting a rotation of the rotor using at least one rotation detecting brush;

differentiating a voltage obtained through the at least one rotation detecting brush;

triggering a pulse generator by the differentiated voltage; and

generating pulses each having a predetermined pulse width based on the triggering of the pulse generator.

19. A method for controlling at least one of a rotational direction, a rotational speed, a rotational position, and a cumulative rotation number of a rotor of a direct current motor, comprising:

driving the direct current motor with a motor driving circuit by applying a direct current drive voltage to a pair of electrode brushes;

detecting a rotation of the rotor using at least one rotation detecting brush;

differentiating a voltage obtained through the at least one rotation detecting brush;

triggering a pulse generator by the differentiated voltage;

generating pulses each having a predetermined pulse width based on the triggering of

the pulse generator; and

controlling the motor driving circuit by reacting to output pulses of the pulse generator.

20. The method according to claim 19, wherein the step of controlling the motor driving circuit comprises:

measuring a pulse interval of output pulses of the pulse generator;

calculating a rotational speed of the rotor based on the pulse interval;

comparing the rotational speed of the rotor with a target rotational speed of the rotor; and

controlling a drive output signal of the motor driving circuit by performing chopping control such that the rotational speed of the rotor reaches the target rotational speed.

21. The method according to claim 20, wherein the step of controlling the motor driving circuit further comprises:

suppressing an invalid rotational speed detection result when a chopping operation is performed.

22. The method according to claim 19, wherein the step of controlling the motor driving circuit comprises:

counting a pulse number of output pulses of the pulse generator;

calculating a cumulative rotation number of the rotor based on the pulse number;

calculating a remaining rotation number based on the cumulative rotation number subtracted from a target cumulative rotation number; and

generating and applying motor control signals to the motor driving circuit based on the remaining rotation number.

23. A method for controlling rotational operations of a direct current motor, comprising:

applying an initial drive voltage as a direct current drive voltage to a pair of electrode brushes to start a rotation of the direct current motor;

detecting a rotation of the direct current motor using at least one rotation detecting

brush;

differentiating a voltage obtained through the at least one rotation detecting brush;

triggering a pulse generator by the differentiated voltage;

generating pulses each having a predetermined pulse width based on the triggering of the pulse generator;

measuring a pulse interval of output pulses of the pulse generator;

calculating a current rotational speed of the direct current motor based on the pulse interval;

comparing the current rotational speed of the direct current motor with a first target rotational speed of the direct current motor; and

adjusting the direct current drive voltage in accordance with a comparison result.

24. The method according to claim 23, wherein the step of adjusting comprises:

increasing the drive voltage when the current rotational speed is lower than the first target rotational speed.

25. The method according to claim 23, wherein the step of adjusting comprises:

decreasing the drive voltage when the current rotational speed is greater than the first target rotational speed.

26. The method according to claim 23, further comprising:

reducing the drive voltage to the pair of electrode brushes to correspond to a second target rotational speed when the current rotational speed reaches the first target rotational speed.

27. The method according to claim 23, further comprising:

reducing the drive voltage to the pair of electrode brushes to correspond to a second target rotational speed when a cumulative rotation number reaches a predetermined rotation number.

ABSTRACT OF THE DISCLOSURE

A direct current motor rotation detecting apparatus and a direct current motor rotation control apparatus detect and control at least one of a rotational direction, a rotational speed, a rotational position, and a cumulative rotation number of a rotor of a direct current motor. The apparatus include at least one rotation detecting brush which detects a rotation of the rotor, a differentiating circuit which differentiates a voltage obtained through the at least one rotation detecting brush, and a pulse generator triggered by the differentiating circuit at a time interval proportional to a rotational speed of the direct current motor to generate pulses having a predetermined pulse width.

I:\atty\SNS\208969US-PA.wpd

FIG. 1

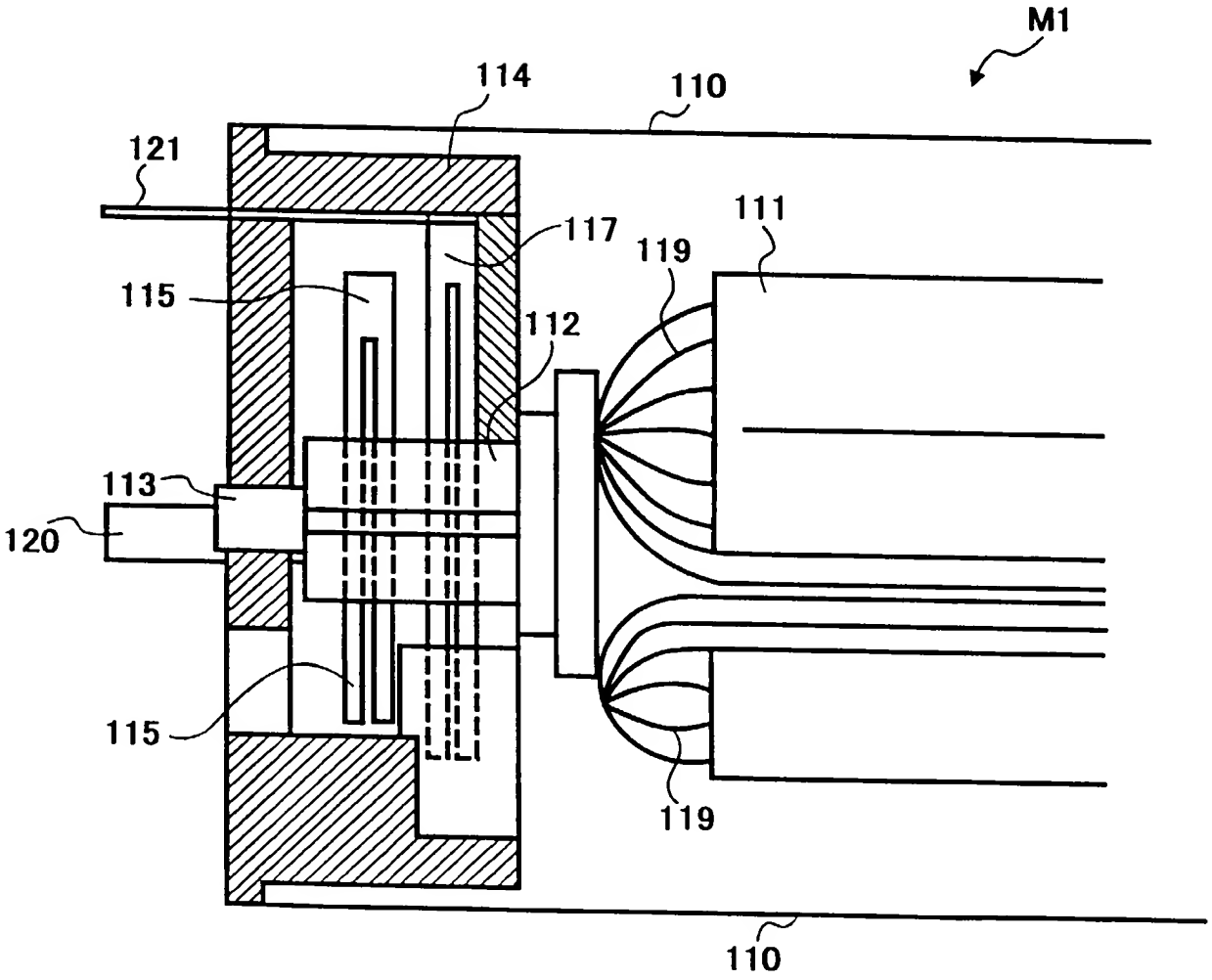


FIG. 2

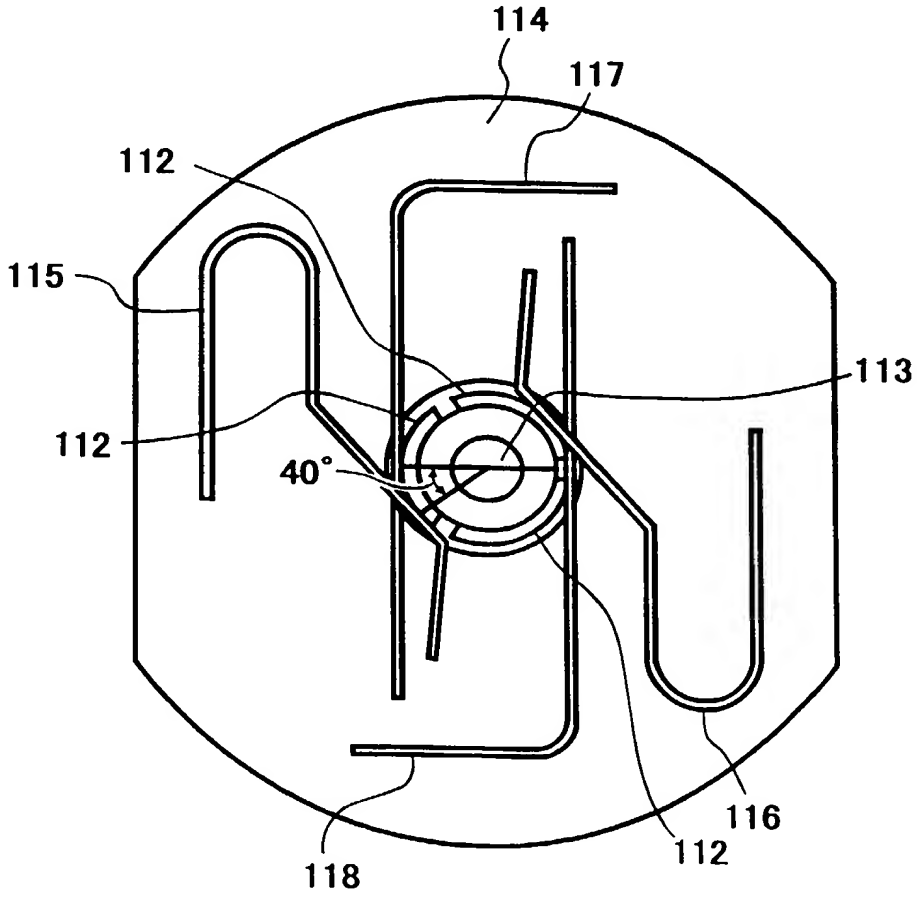


FIG. 3

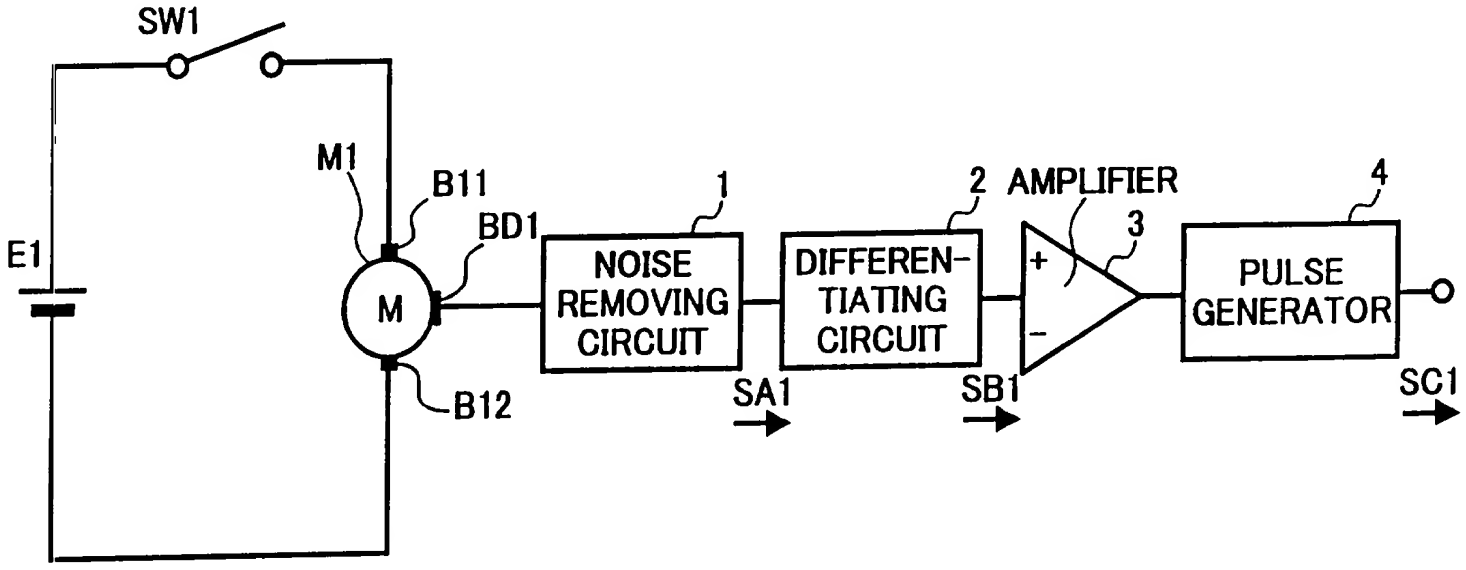

SW1
M1
B11
BD1
E1
M
B12
NOISE REMOVING CIRCUIT
1
DIFFEREN-TIATING CIRCUIT
2
AMPLIFIER
3
+
−
PULSE GENERATOR
4
SA1
SB1
SC1

FIG. 4

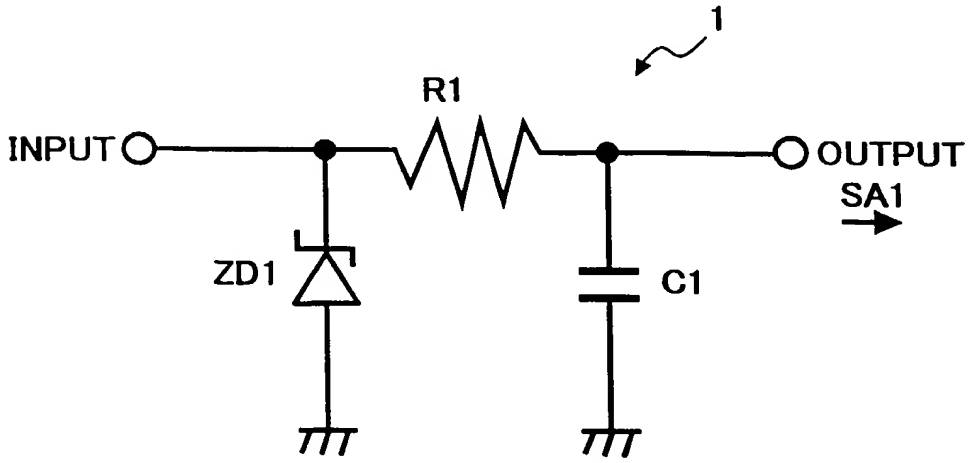


FIG. 5

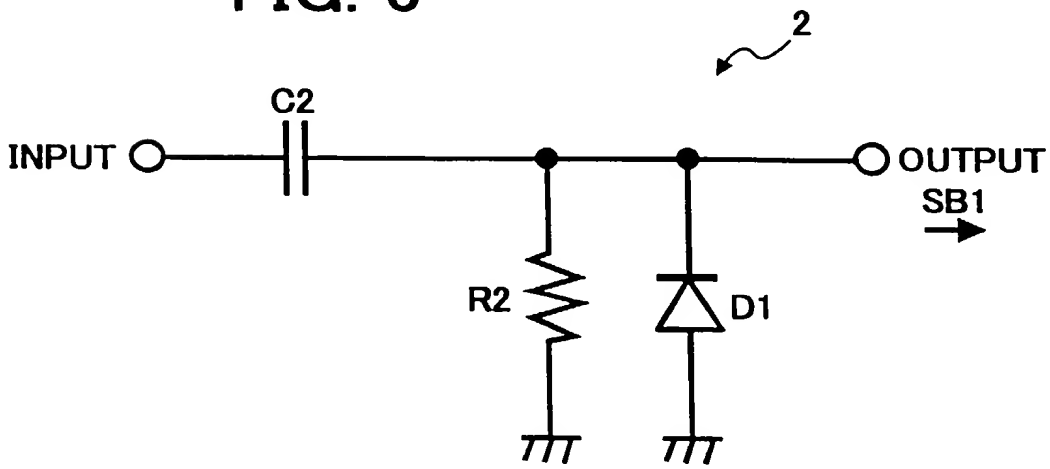


FIG. 6

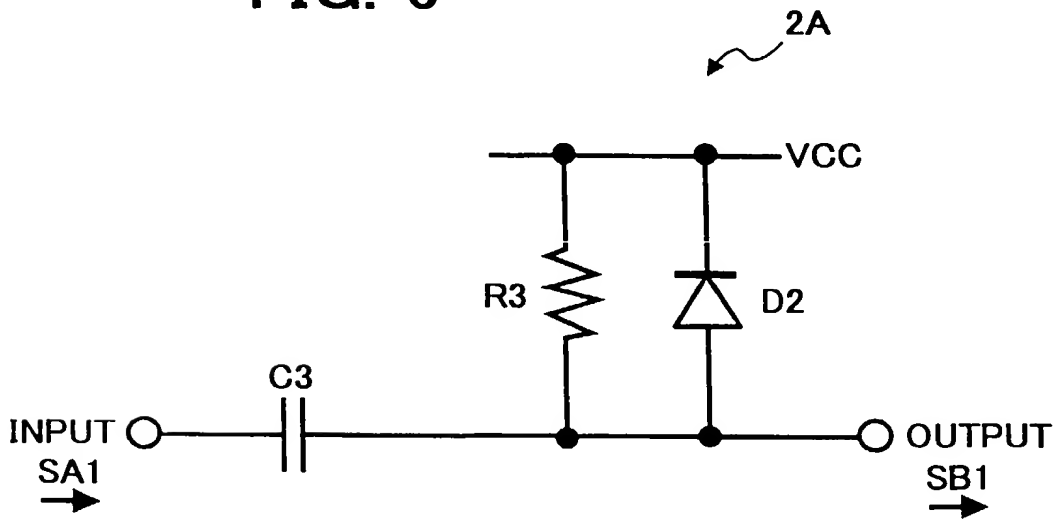


FIG. 7

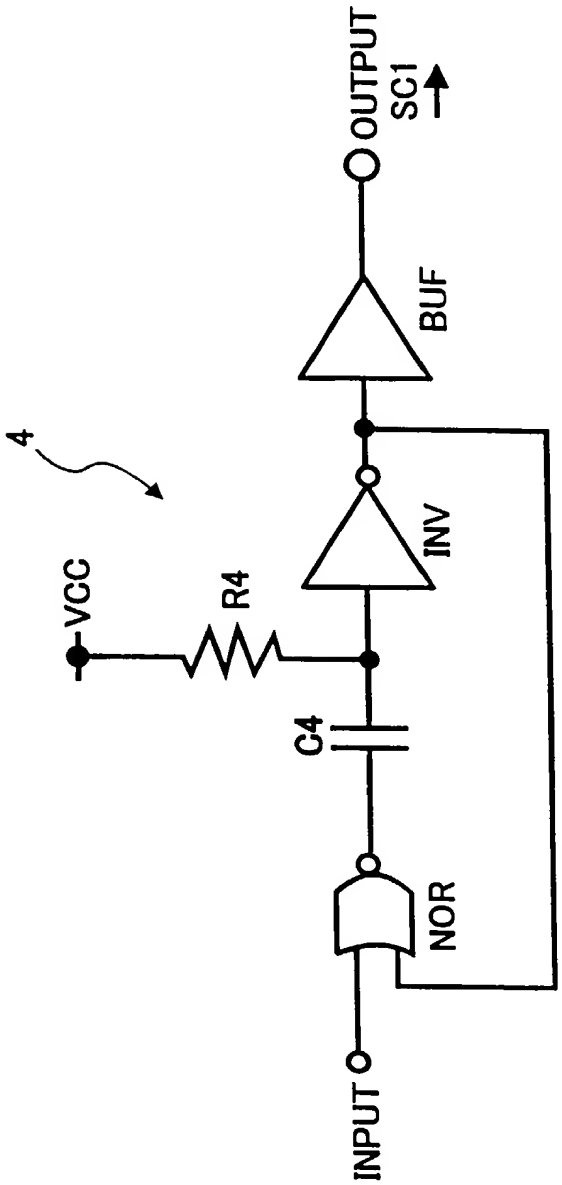


FIG. 8A

ROTATION DETECTING BRUSH
OUTPUT SIGNAL
(AFTER REMOVING NOISE)

FIG. 8B

DIFFERENTIATING CIRCUIT
OUTPUT SIGNAL

FIG. 8C

PULSE GENERATOR
OUTPUT SIGNAL

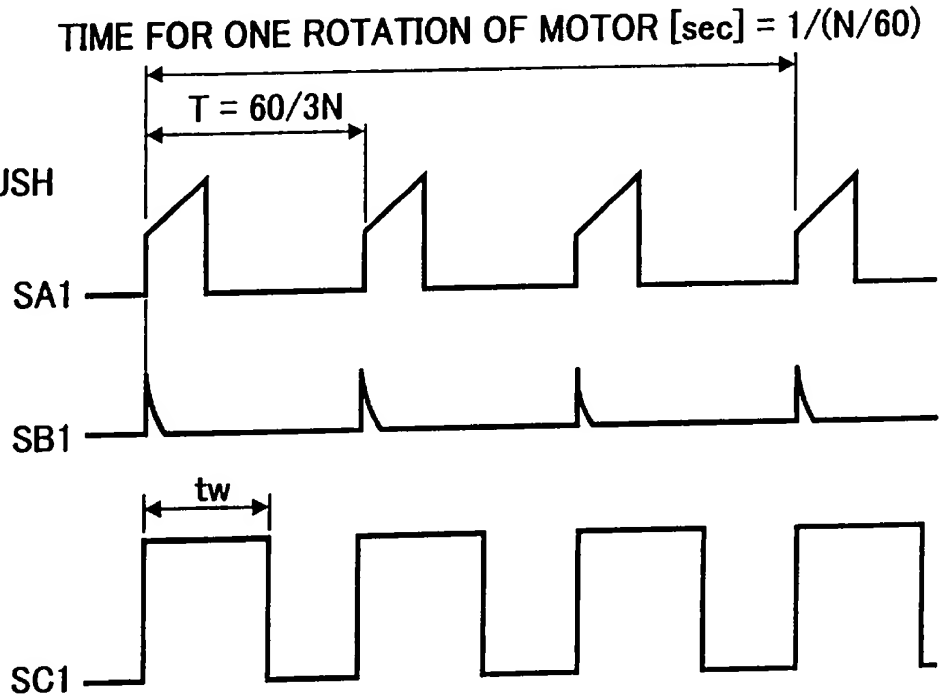
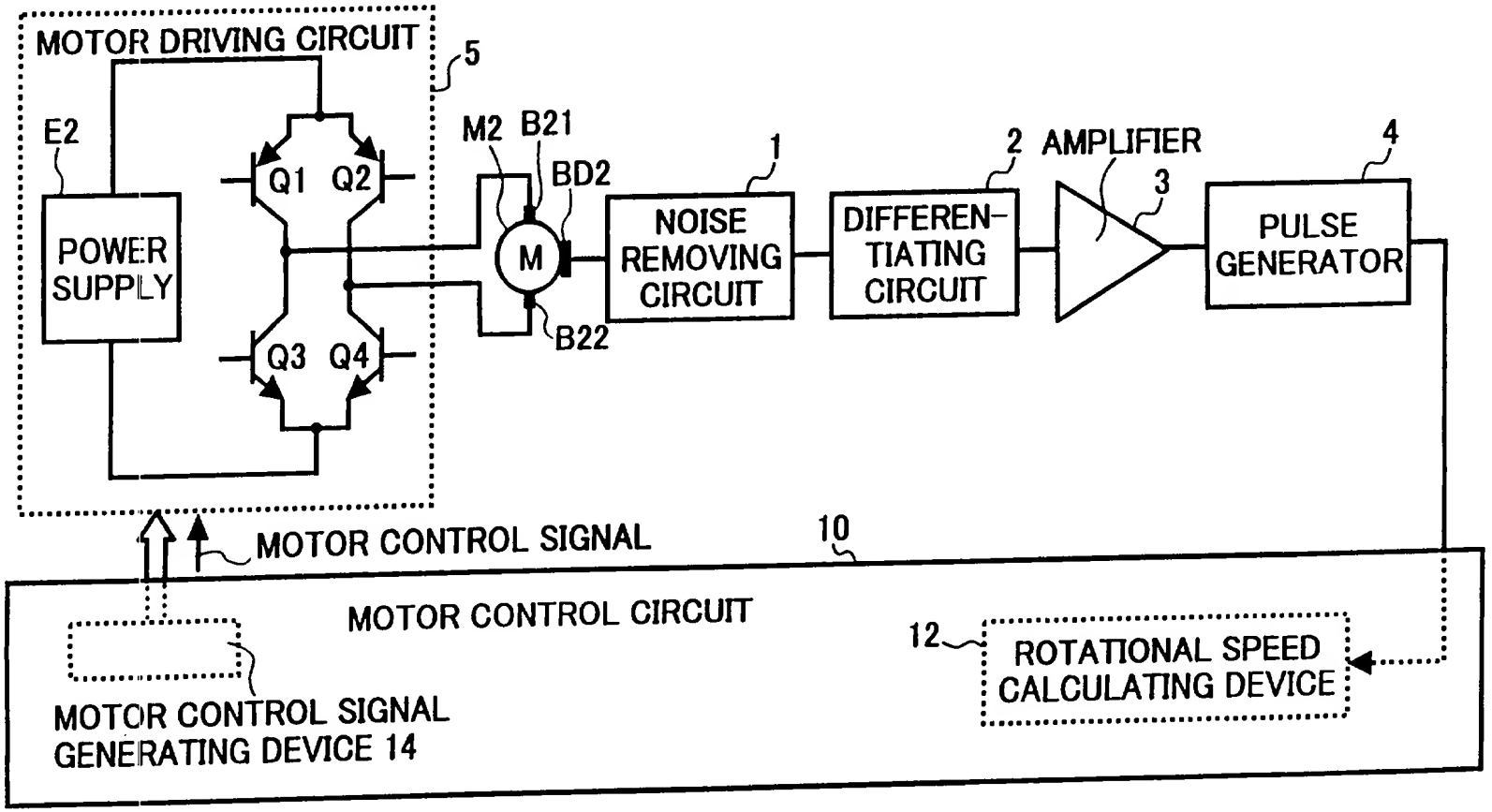


FIG. 9


MOTOR DRIVING CIRCUIT
5
E2
POWER SUPPLY
Q1
Q2
Q3
Q4
M2
B21
BD2
M
B22
1
NOISE REMOVING CIRCUIT
2
DIFFEREN-TIATING CIRCUIT
AMPLIFIER
3
4
PULSE GENERATOR
MOTOR CONTROL SIGNAL
10
MOTOR CONTROL CIRCUIT
12
ROTATIONAL SPEED CALCULATING DEVICE
MOTOR CONTROL SIGNAL GENERATING DEVICE 14

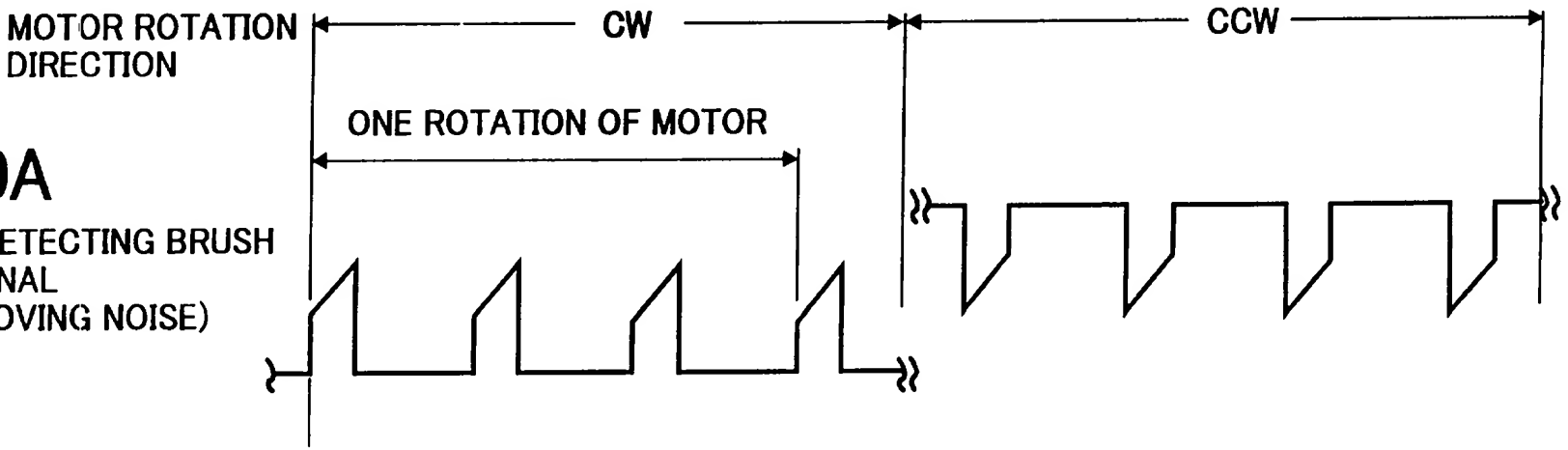


FIG. 10A

ROTATION DETECTING BRUSH OUTPUT SIGNAL (AFTER REMOVING NOISE)

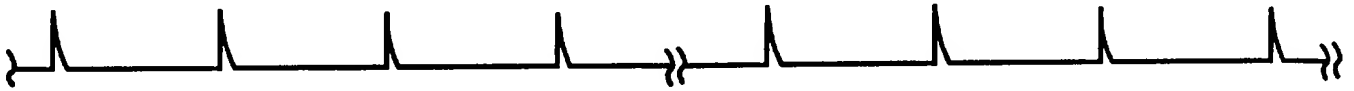


FIG. 10B

DIFFERENTIATING CIRCUIT OUTPUT SIGNAL

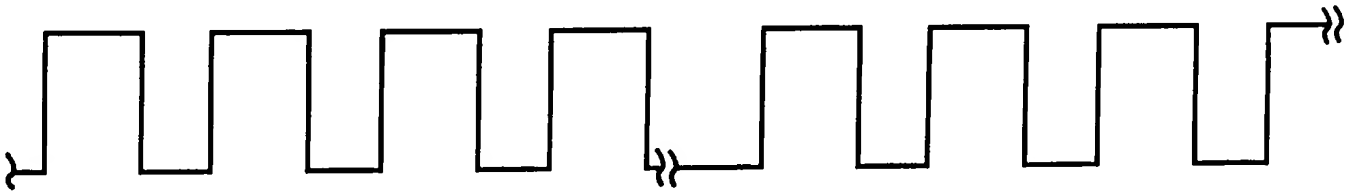


FIG. 10C

PULSE GENERATOR OUTPUT SIGNAL

FIG. 11

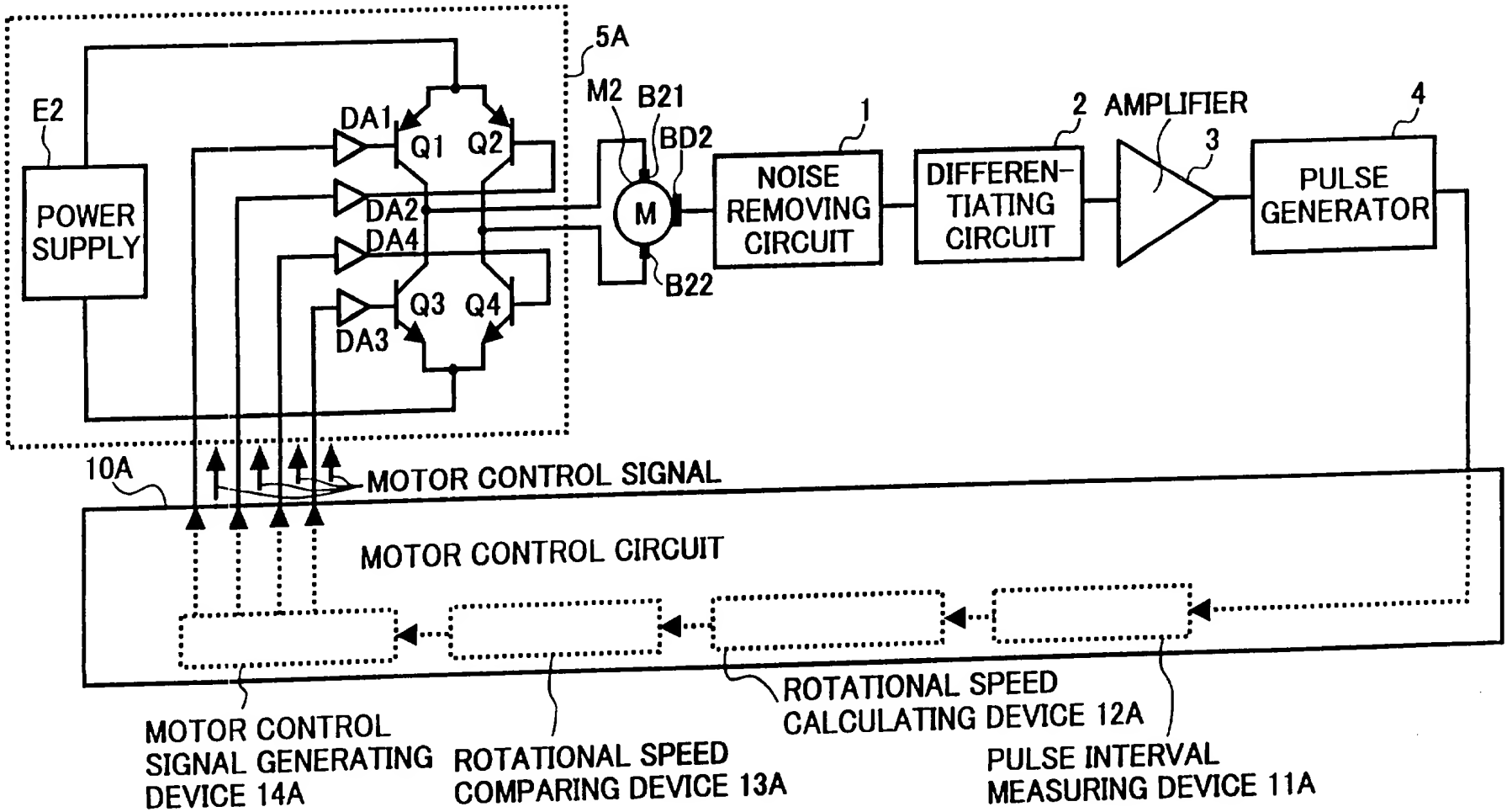

5A
E2
DA1
Q1
Q2
M2
B21
BD2
1
2
AMPLIFIER
4
3
POWER SUPPLY
DA2
DA4
M
NOISE REMOVING CIRCUIT
DIFFEREN-TIATING CIRCUIT
PULSE GENERATOR
Q3
Q4
DA3
B22
10A
MOTOR CONTROL SIGNAL
MOTOR CONTROL CIRCUIT
ROTATIONAL SPEED CALCULATING DEVICE 12A
MOTOR CONTROL SIGNAL GENERATING DEVICE 14A
ROTATIONAL SPEED COMPARING DEVICE 13A
PULSE INTERVAL MEASURING DEVICE 11A

FIG. 12

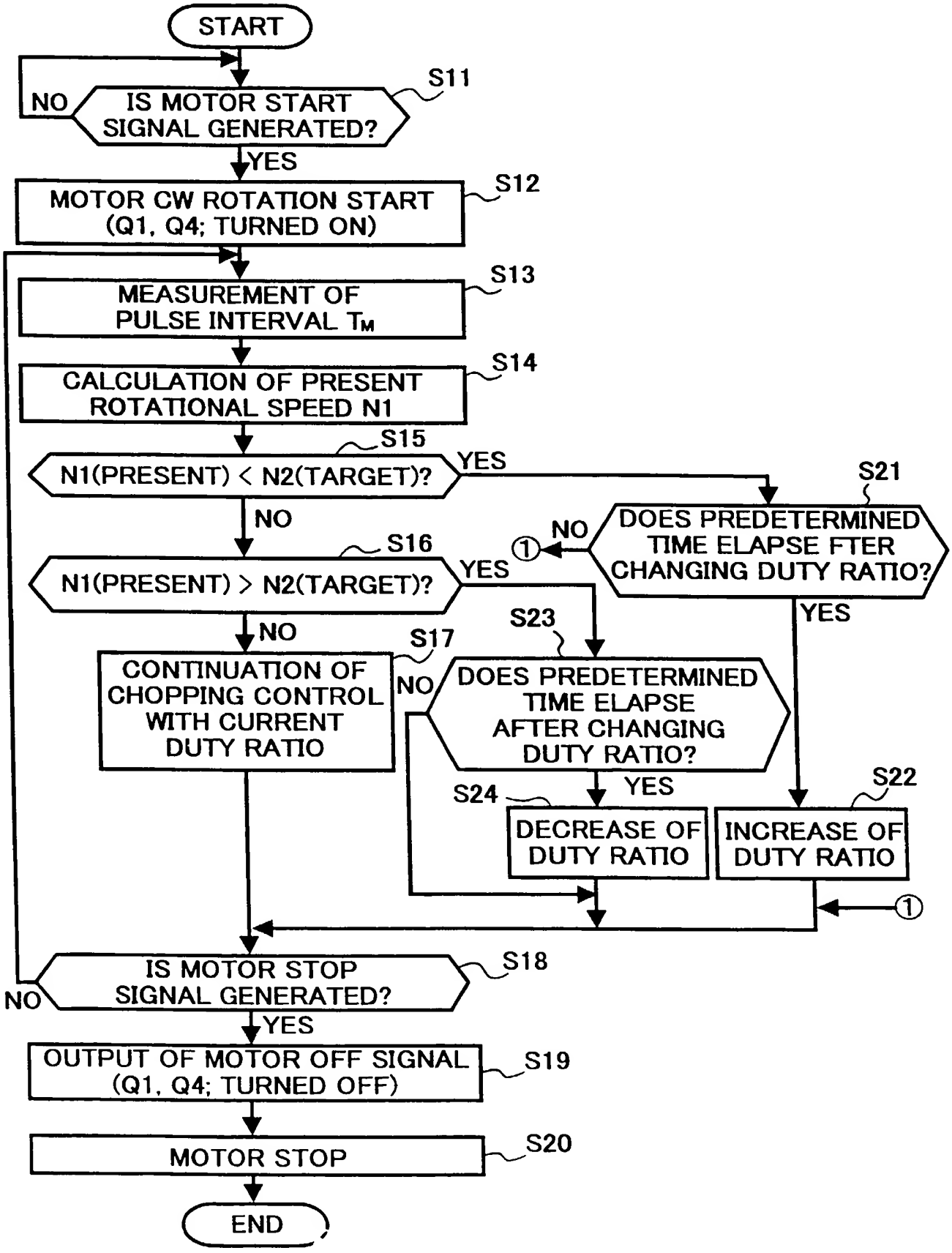

START
S11
NO
IS MOTOR START SIGNAL GENERATED?
YES
S12
MOTOR CW ROTATION START (Q1, Q4; TURNED ON)
S13
MEASUREMENT OF PULSE INTERVAL T_M
S14
CALCULATION OF PRESENT ROTATIONAL SPEED N1
S15
N1(PRESENT) < N2(TARGET)?
YES
S21
NO
DOES PREDETERMINED TIME ELAPSE FTER CHANGING DUTY RATIO?
NO
①
S16
N1(PRESENT) > N2(TARGET)?
YES
YES
NO
S23
S17
CONTINUATION OF CHOPPING CONTROL WITH CURRENT DUTY RATIO
NO
DOES PREDETERMINED TIME ELAPSE AFTER CHANGING DUTY RATIO?
YES
S24
S22
DECREASE OF DUTY RATIO
INCREASE OF DUTY RATIO
①
S18
NO
IS MOTOR STOP SIGNAL GENERATED?
YES
S19
OUTPUT OF MOTOR OFF SIGNAL (Q1, Q4; TURNED OFF)
S20
MOTOR STOP
END

FIG. 13A
TRANSISTOR Q1
ON/OFF CONTROL SIGNAL

FIG. 13B
TRANSISTOR Q4
ON/OFF CONTROL SIGNAL

FIG. 13C
DIFFERENTIATING CIRCUIT
INPUT SIGNAL
(ROTATION DETECTING
BRUSH OUTPUT SIGNAL)

FIG. 13D
PULSE GENERATOR
OUTPUT SIGNAL

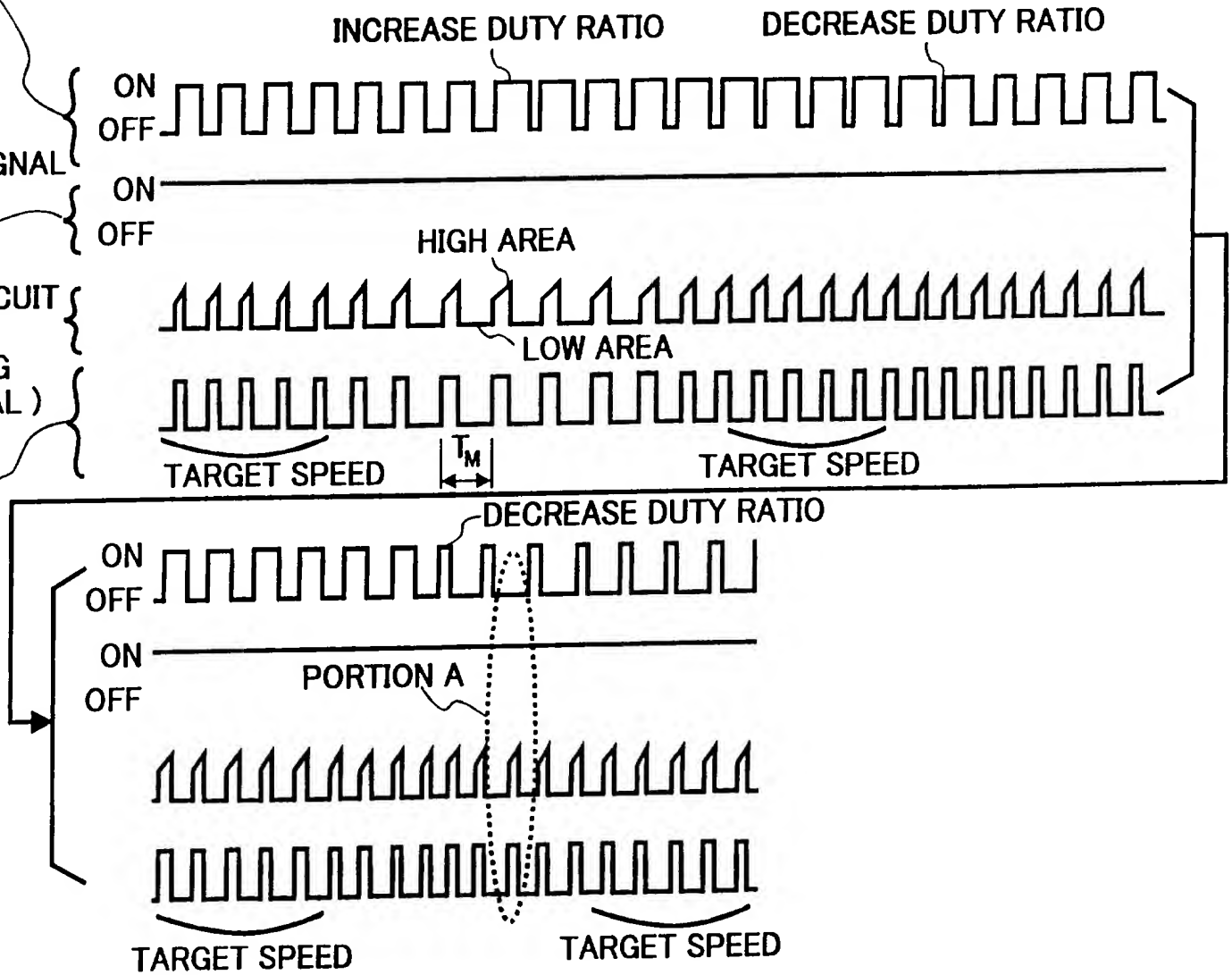


FIG. 14A

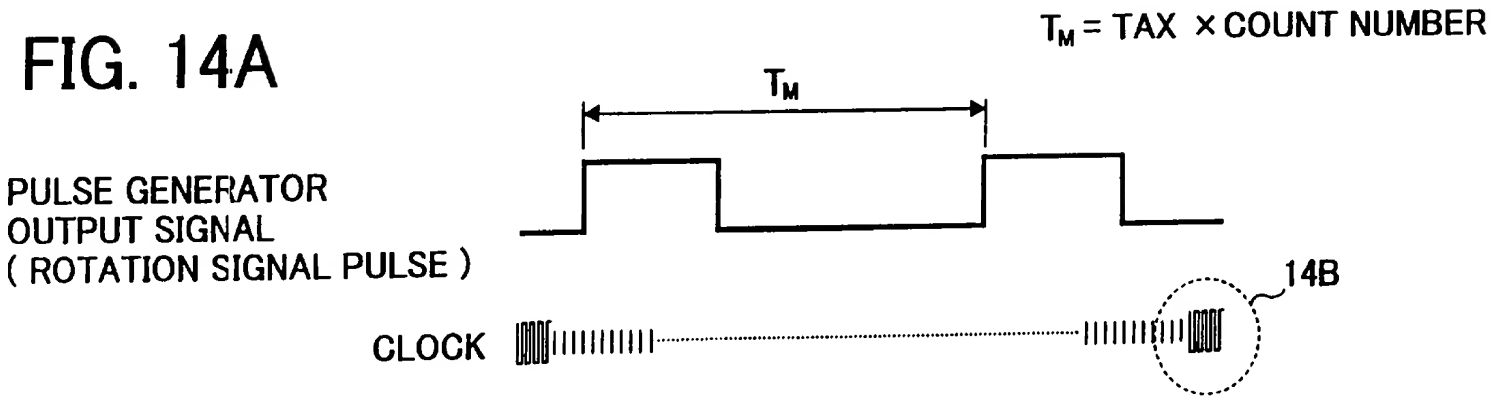


FIG. 14B

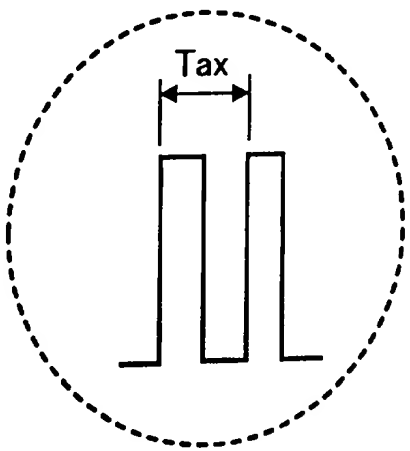


FIG. 15

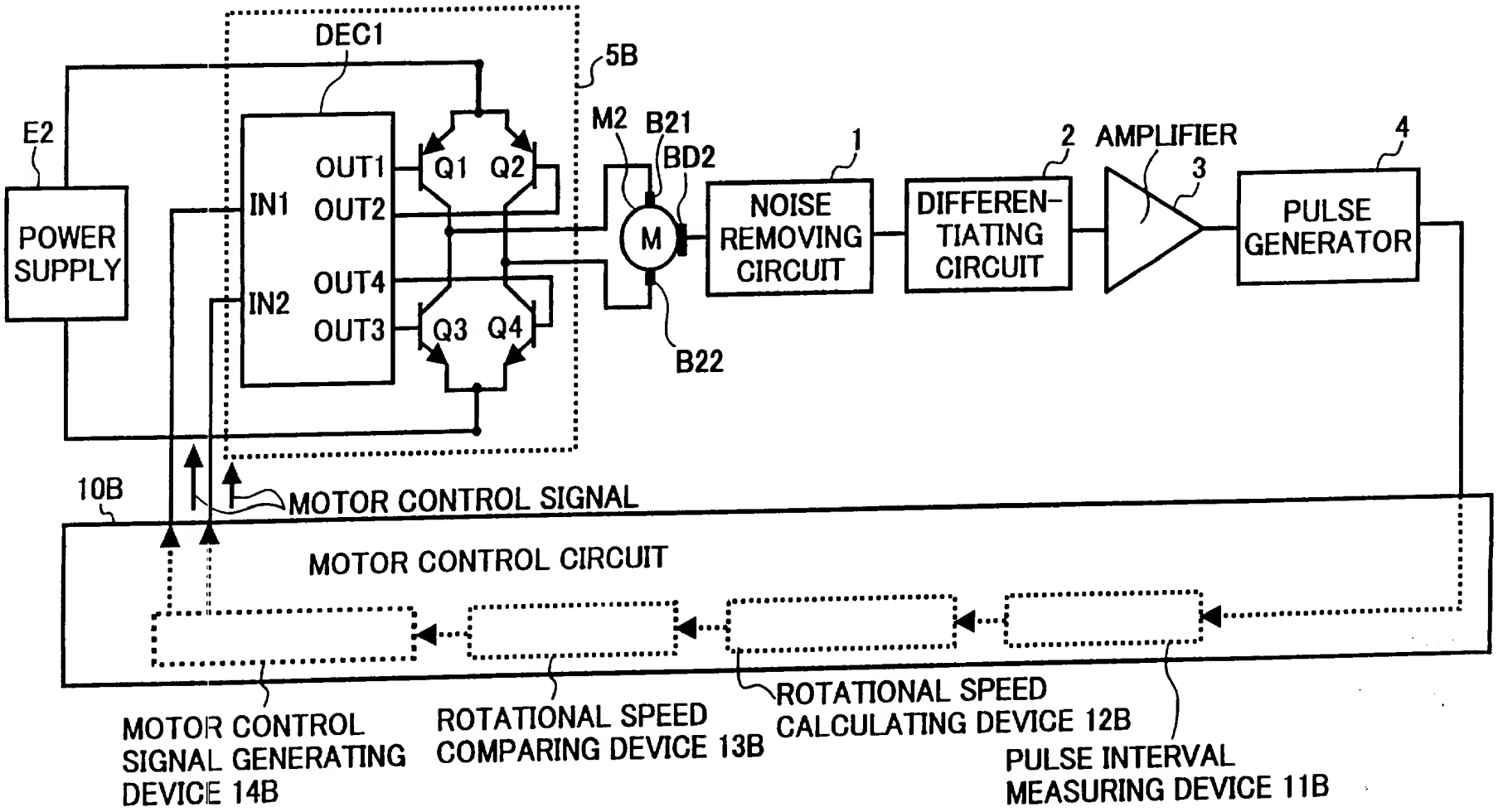

DEC1
5B
E2
POWER SUPPLY
IN1
IN2
OUT1
OUT2
OUT4
OUT3
Q1
Q2
Q3
Q4
M2
B21
BD2
M
B22
1
NOISE REMOVING CIRCUIT
2
DIFFEREN-TIATING CIRCUIT
AMPLIFIER
3
4
PULSE GENERATOR
10B
MOTOR CONTROL SIGNAL
MOTOR CONTROL CIRCUIT
MOTOR CONTROL SIGNAL GENERATING DEVICE 14B
ROTATIONAL SPEED COMPARING DEVICE 13B
ROTATIONAL SPEED CALCULATING DEVICE 12B
PULSE INTERVAL MEASURING DEVICE 11B

FIG. 16

IN1	IN2	OUT1	OUT2	OUT3	OUT4	Q1	Q2	Q3	Q4	MOTOR CONDITION
L	L	H	H	L	L	OFF	OFF	OFF	OFF	STOP
L	H	H	L	H	L	OFF	ON	ON	OFF	CCW ROTATION
H	L	L	H	L	H	ON	OFF	OFF	ON	CW ROTATION
H	H	H	H	H	H	OFF	OFF	ON	ON	BRAKE (SHUNT)

FIG. 17

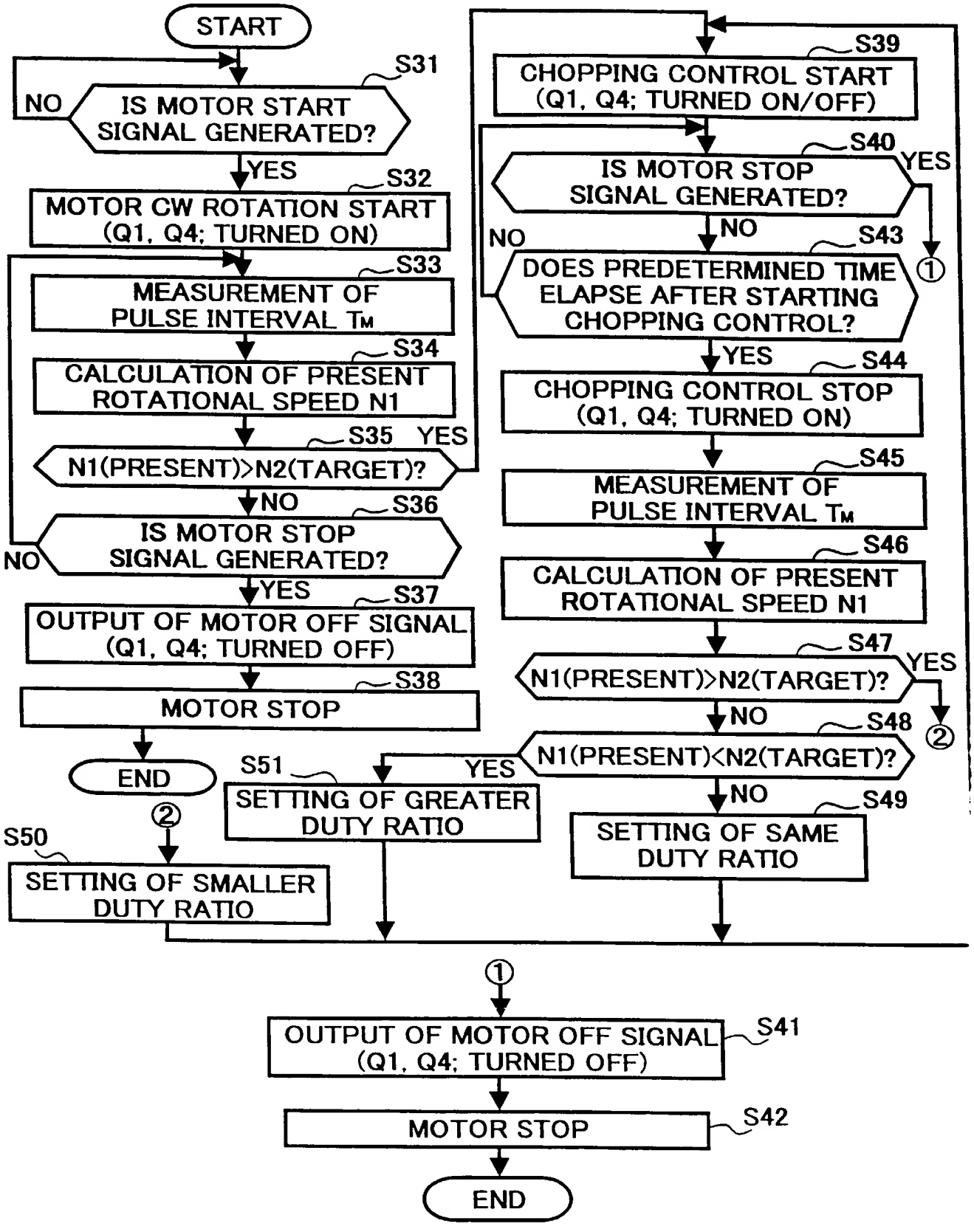

START
S31
NO
IS MOTOR START SIGNAL GENERATED?
YES
S32
MOTOR CW ROTATION START (Q1, Q4; TURNED ON)
S33
MEASUREMENT OF PULSE INTERVAL TM
S34
CALCULATION OF PRESENT ROTATIONAL SPEED N1
S35
YES
N1(PRESENT)>N2(TARGET)?
NO
S36
NO
IS MOTOR STOP SIGNAL GENERATED?
YES
S37
OUTPUT OF MOTOR OFF SIGNAL (Q1, Q4; TURNED OFF)
S38
MOTOR STOP
END
②
S50
SETTING OF SMALLER DUTY RATIO
S39
CHOPPING CONTROL START (Q1, Q4; TURNED ON/OFF)
S40
IS MOTOR STOP SIGNAL GENERATED?
YES
NO
S43
DOES PREDETERMINED TIME ELAPSE AFTER STARTING CHOPPING CONTROL?
①
YES
S44
CHOPPING CONTROL STOP (Q1, Q4; TURNED ON)
S45
MEASUREMENT OF PULSE INTERVAL TM
S46
CALCULATION OF PRESENT ROTATIONAL SPEED N1
S47
N1(PRESENT)>N2(TARGET)?
YES
②
NO
S48
N1(PRESENT)<N2(TARGET)?
YES
S51
SETTING OF GREATER DUTY RATIO
NO
S49
SETTING OF SAME DUTY RATIO
①
S41
OUTPUT OF MOTOR OFF SIGNAL (Q1, Q4; TURNED OFF)
S42
MOTOR STOP
END

FIG. 18A
TRANSISTOR Q1
ON/OFF CONTROL SIGNAL

FIG. 18B
TRANSISTOR Q4
ON/OFF CONTROL SIGNAL

FIG. 18C
DIFFERENTIATING CIRCUIT
INPUT SIGNAL
(ROTATION DETECTING
BRUSH OUTPUT SIGNAL)

FIG. 18D
PULSE GENERATOR
OUTPUT SIGNAL

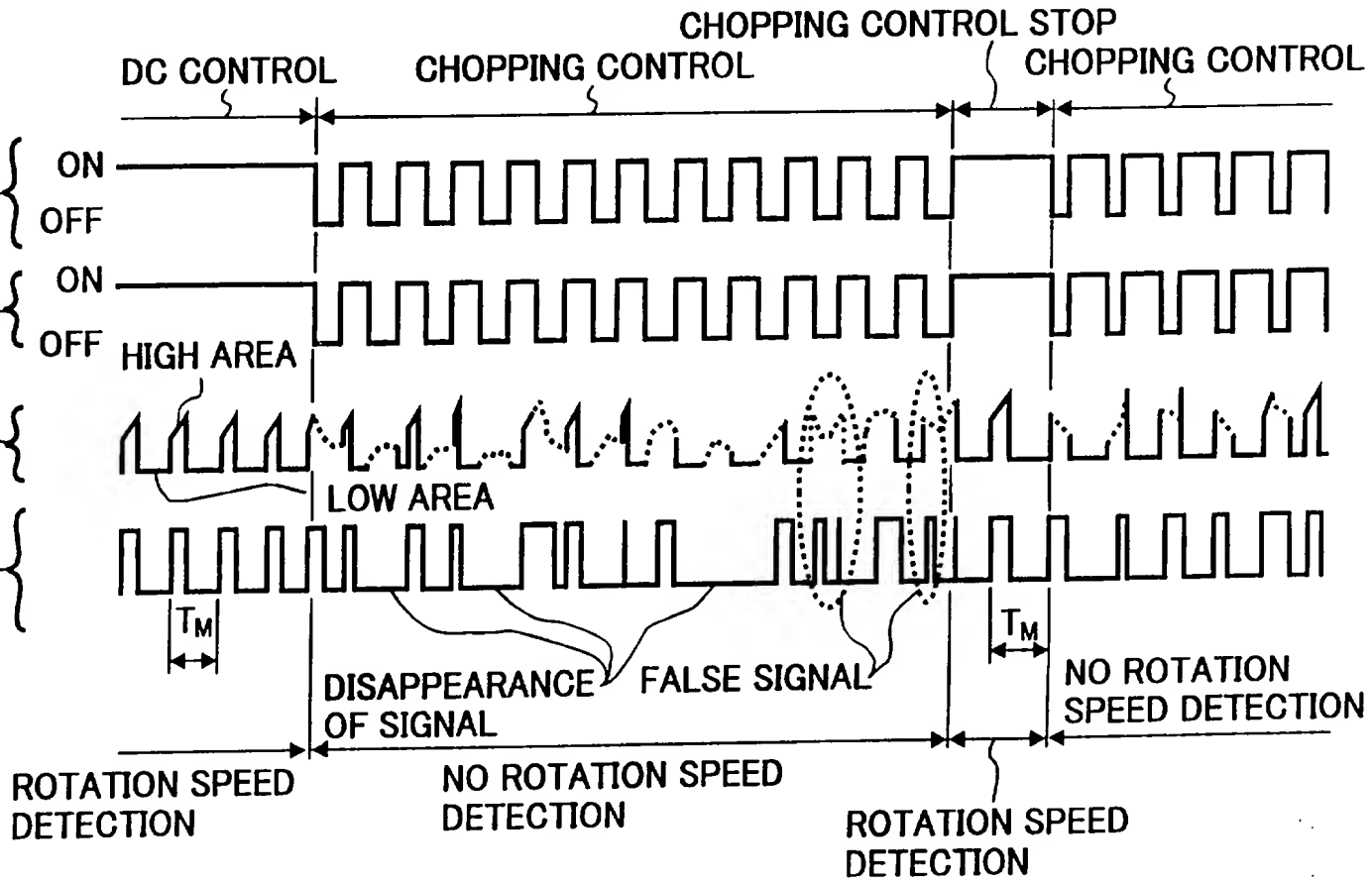


FIG. 19A

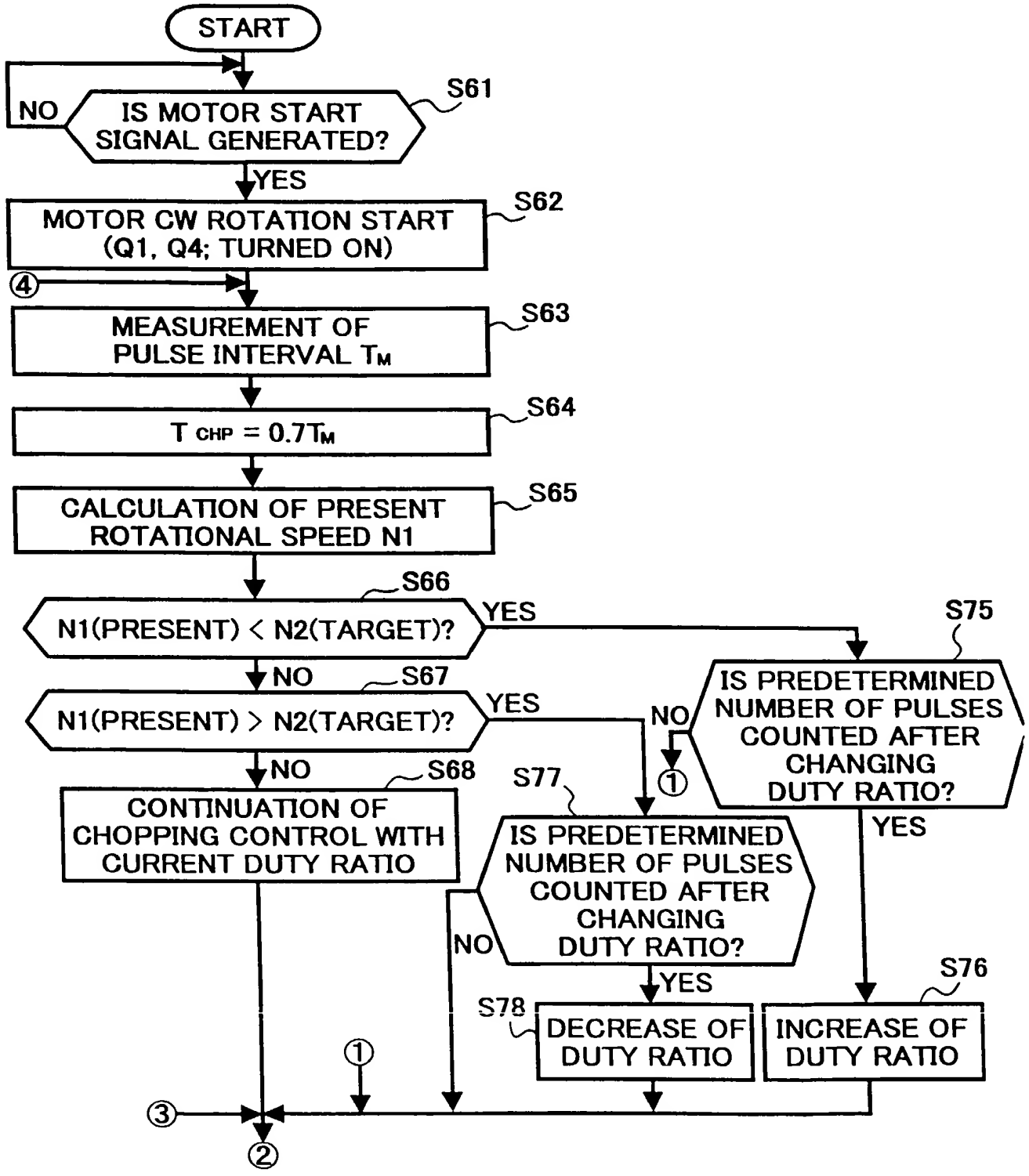

START
S61
NO
IS MOTOR START SIGNAL GENERATED?
YES
S62
MOTOR CW ROTATION START (Q1, Q4; TURNED ON)
④
S63
MEASUREMENT OF PULSE INTERVAL T_M
S64
$T_{CHP} = 0.7T_M$
S65
CALCULATION OF PRESENT ROTATIONAL SPEED N1
S66
N1(PRESENT) < N2(TARGET)?
YES
S75
NO
S67
N1(PRESENT) > N2(TARGET)?
YES
IS PREDETERMINED NUMBER OF PULSES COUNTED AFTER CHANGING DUTY RATIO?
NO
①
NO
S68
S77
CONTINUATION OF CHOPPING CONTROL WITH CURRENT DUTY RATIO
IS PREDETERMINED NUMBER OF PULSES COUNTED AFTER CHANGING DUTY RATIO?
YES
NO
YES
S76
S78
DECREASE OF DUTY RATIO
INCREASE OF DUTY RATIO
①
③
②

FIG. 19B

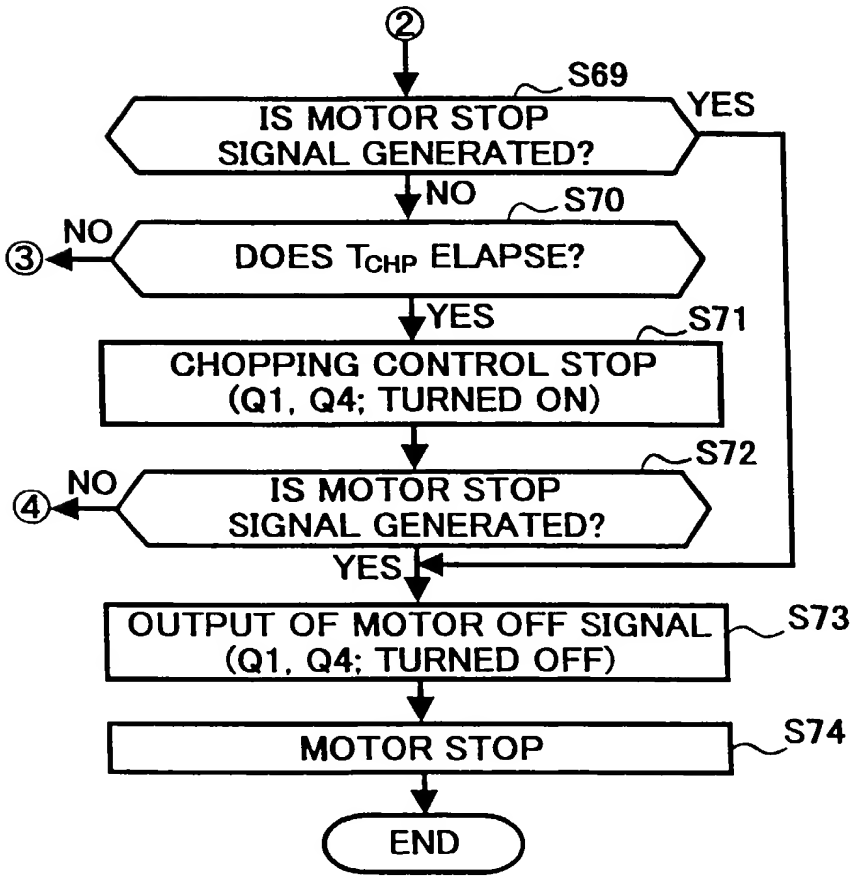

②
S69
IS MOTOR STOP SIGNAL GENERATED?
YES
NO
S70
NO
③
DOES T_{CHP} ELAPSE?
YES
S71
CHOPPING CONTROL STOP (Q1, Q4; TURNED ON)
S72
NO
④
IS MOTOR STOP SIGNAL GENERATED?
YES
OUTPUT OF MOTOR OFF SIGNAL (Q1, Q4; TURNED OFF)
S73
MOTOR STOP
S74
END

FIG. 20A
TRANSISTOR Q1
ON/OFF CONTROL SIGNAL

FIG. 20B
TRANSISTOR Q4
ON/OFF CONTROL SIGNAL

FIG. 20C
DIFFERENTIATING CIRCUIT
INPUT SIGNAL
(ROTATION DETECTING
BRUSH OUTPUT SIGNAL)

FIG. 20D
PULSE GENERATOR
OUTPUT SIGNAL

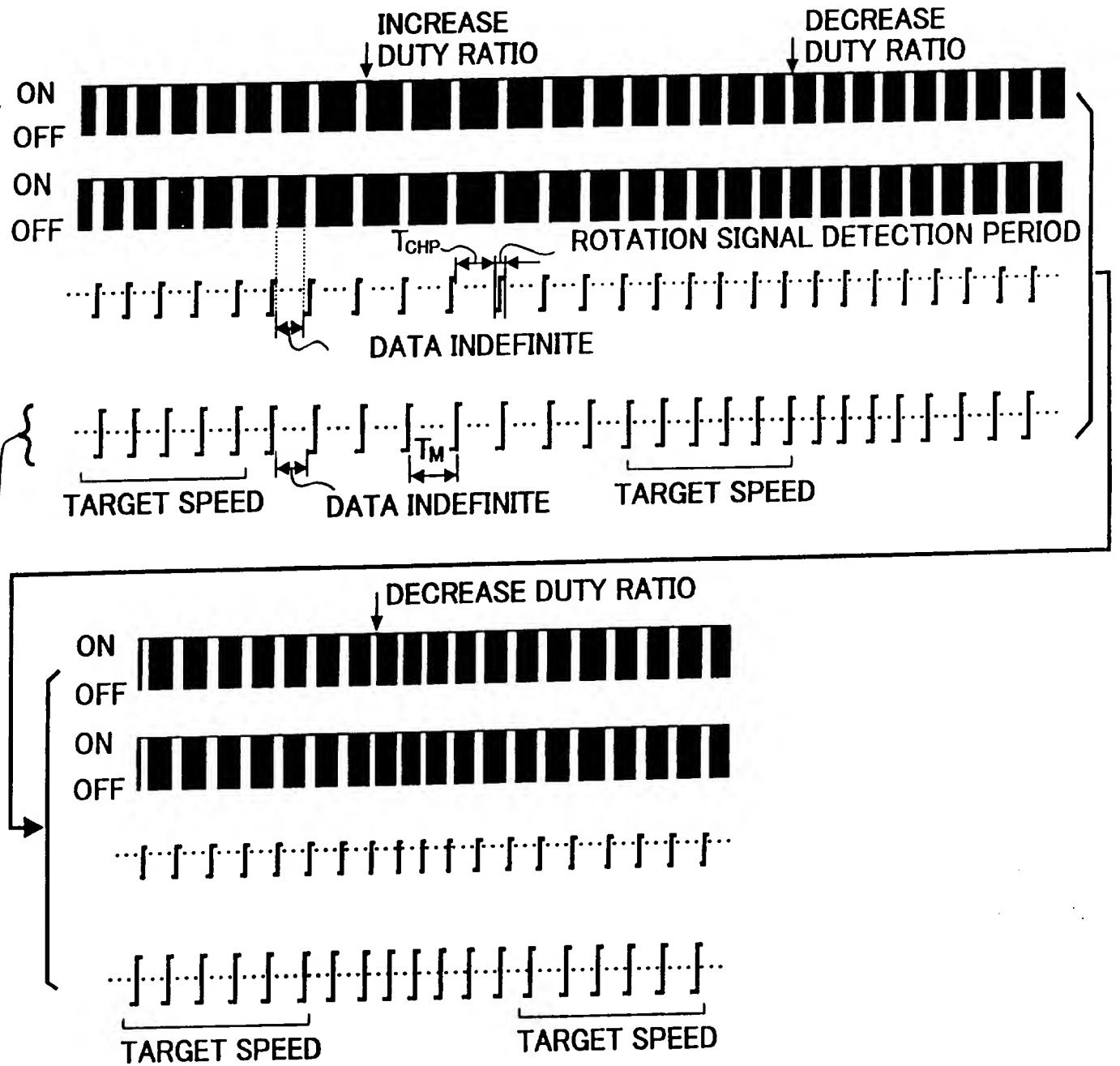


FIG. 21

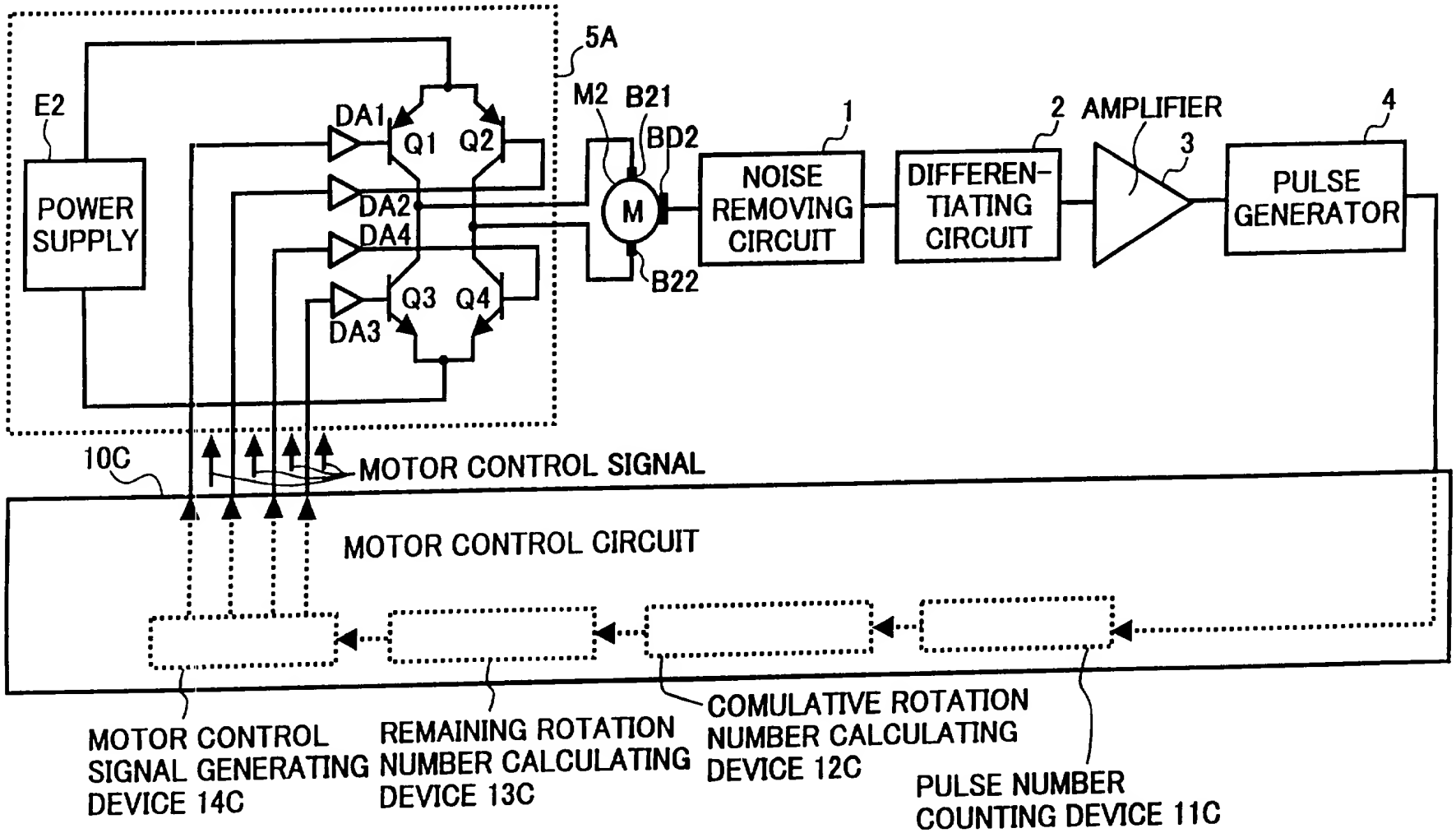

5A
E2
DA1
Q1
Q2
M2
B21
BD2
1
2
AMPLIFIER
3
4
POWER SUPPLY
DA2
DA4
M
NOISE REMOVING CIRCUIT
DIFFEREN-TIATING CIRCUIT
PULSE GENERATOR
Q3
Q4
DA3
B22
10C
MOTOR CONTROL SIGNAL
MOTOR CONTROL CIRCUIT
MOTOR CONTROL SIGNAL GENERATING DEVICE 14C
REMAINING ROTATION NUMBER CALCULATING DEVICE 13C
COMULATIVE ROTATION NUMBER CALCULATING DEVICE 12C
PULSE NUMBER COUNTING DEVICE 11C

FIG. 22

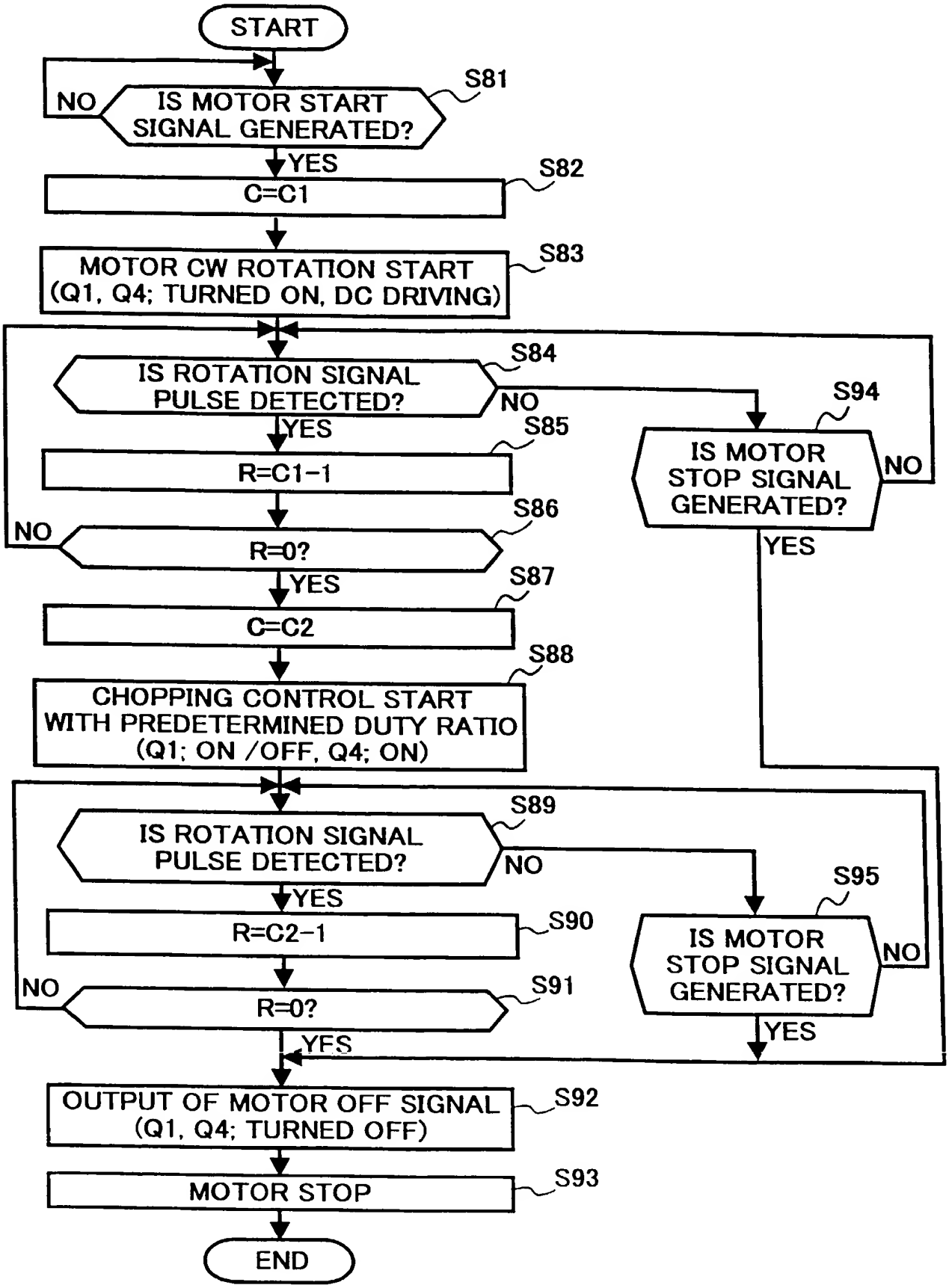

START
S81
NO
IS MOTOR START SIGNAL GENERATED?
YES
S82
C=C1
S83
MOTOR CW ROTATION START (Q1, Q4; TURNED ON, DC DRIVING)
S84
IS ROTATION SIGNAL PULSE DETECTED?
NO
YES
S85
R=C1-1
S86
NO
R=0?
YES
S87
C=C2
S88
CHOPPING CONTROL START WITH PREDETERMINED DUTY RATIO (Q1; ON /OFF, Q4; ON)
S89
IS ROTATION SIGNAL PULSE DETECTED?
NO
YES
S90
R=C2-1
S91
NO
R=0?
YES
S92
OUTPUT OF MOTOR OFF SIGNAL (Q1, Q4; TURNED OFF)
S93
MOTOR STOP
END
S94
IS MOTOR STOP SIGNAL GENERATED?
NO
YES
S95
IS MOTOR STOP SIGNAL GENERATED?
NO
YES

FIG. 23A

FIG. 23B

FIG. 23C

FIG. 23D

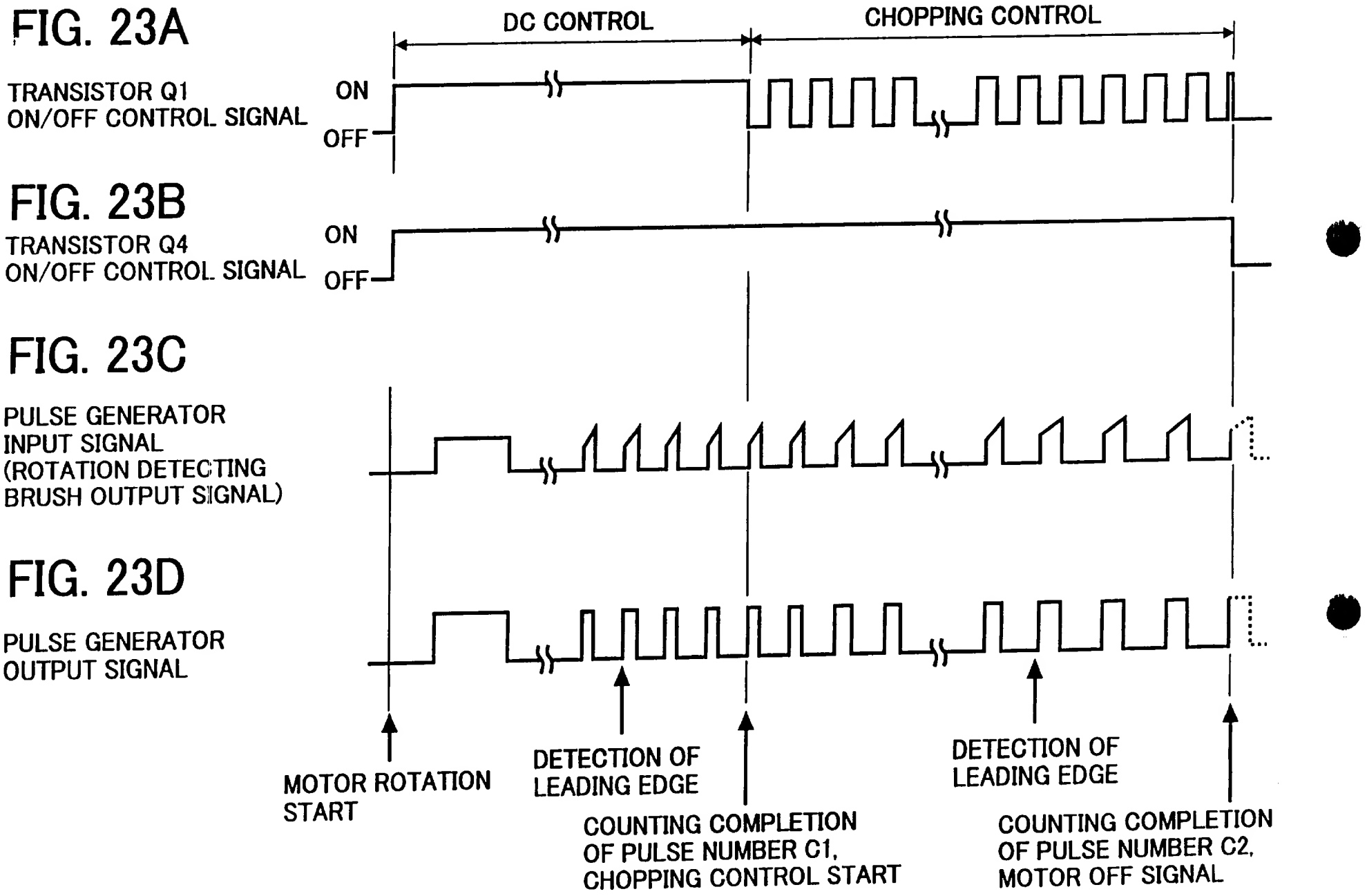


FIG. 24

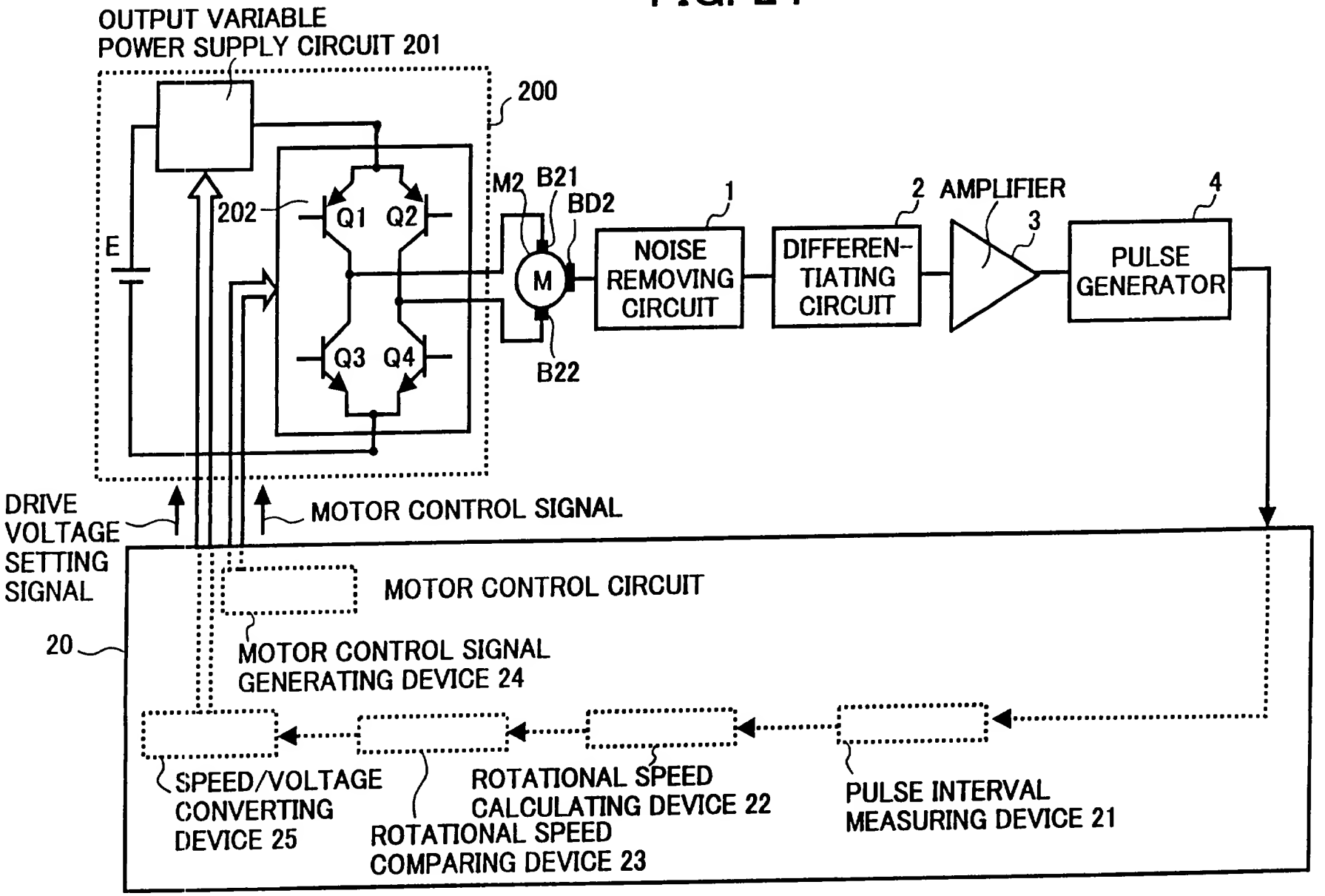

OUTPUT VARIABLE
POWER SUPPLY CIRCUIT 201
200
202
Q1
Q2
Q3
Q4
E
M2
B21
BD2
B22
M
1
NOISE
REMOVING
CIRCUIT
2
DIFFEREN-
TIATING
CIRCUIT
AMPLIFIER
3
4
PULSE
GENERATOR
DRIVE
VOLTAGE
SETTING
SIGNAL
MOTOR CONTROL SIGNAL
20
MOTOR CONTROL CIRCUIT
MOTOR CONTROL SIGNAL
GENERATING DEVICE 24
SPEED/VOLTAGE
CONVERTING
DEVICE 25
ROTATIONAL SPEED
COMPARING DEVICE 23
ROTATIONAL SPEED
CALCULATING DEVICE 22
PULSE INTERVAL
MEASURING DEVICE 21

FIG. 25

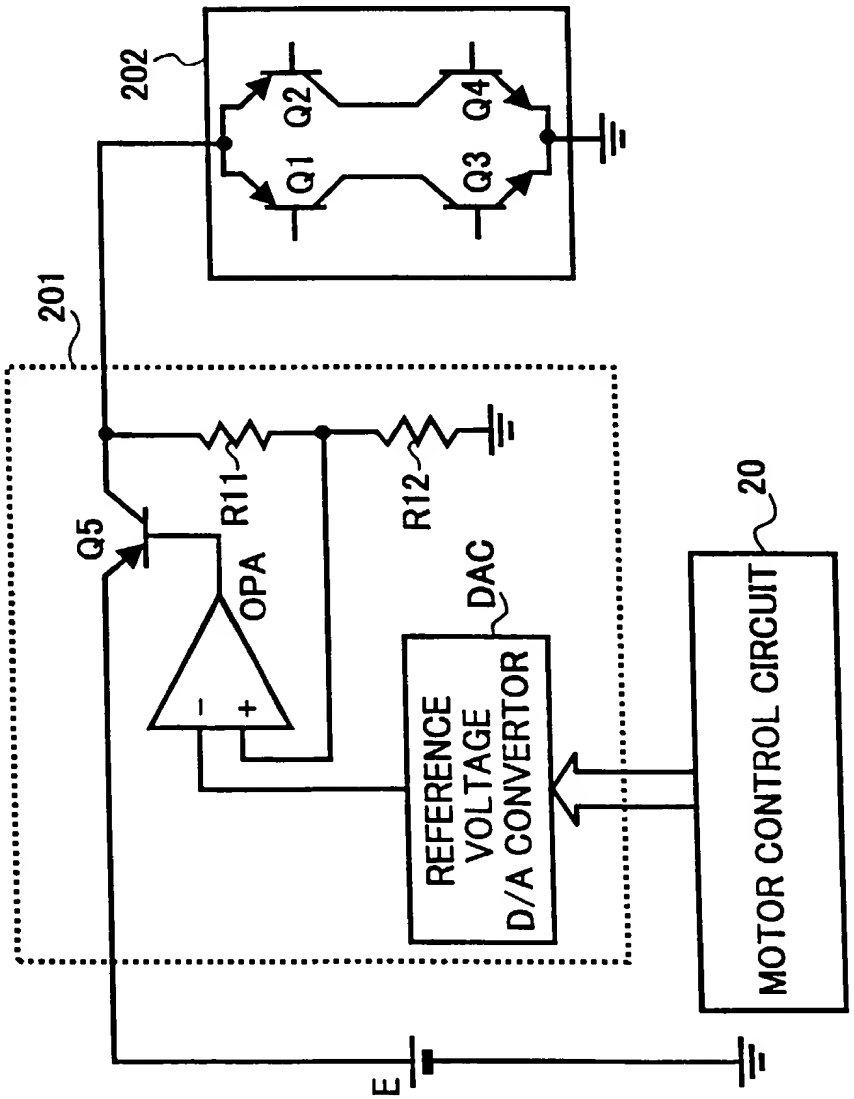
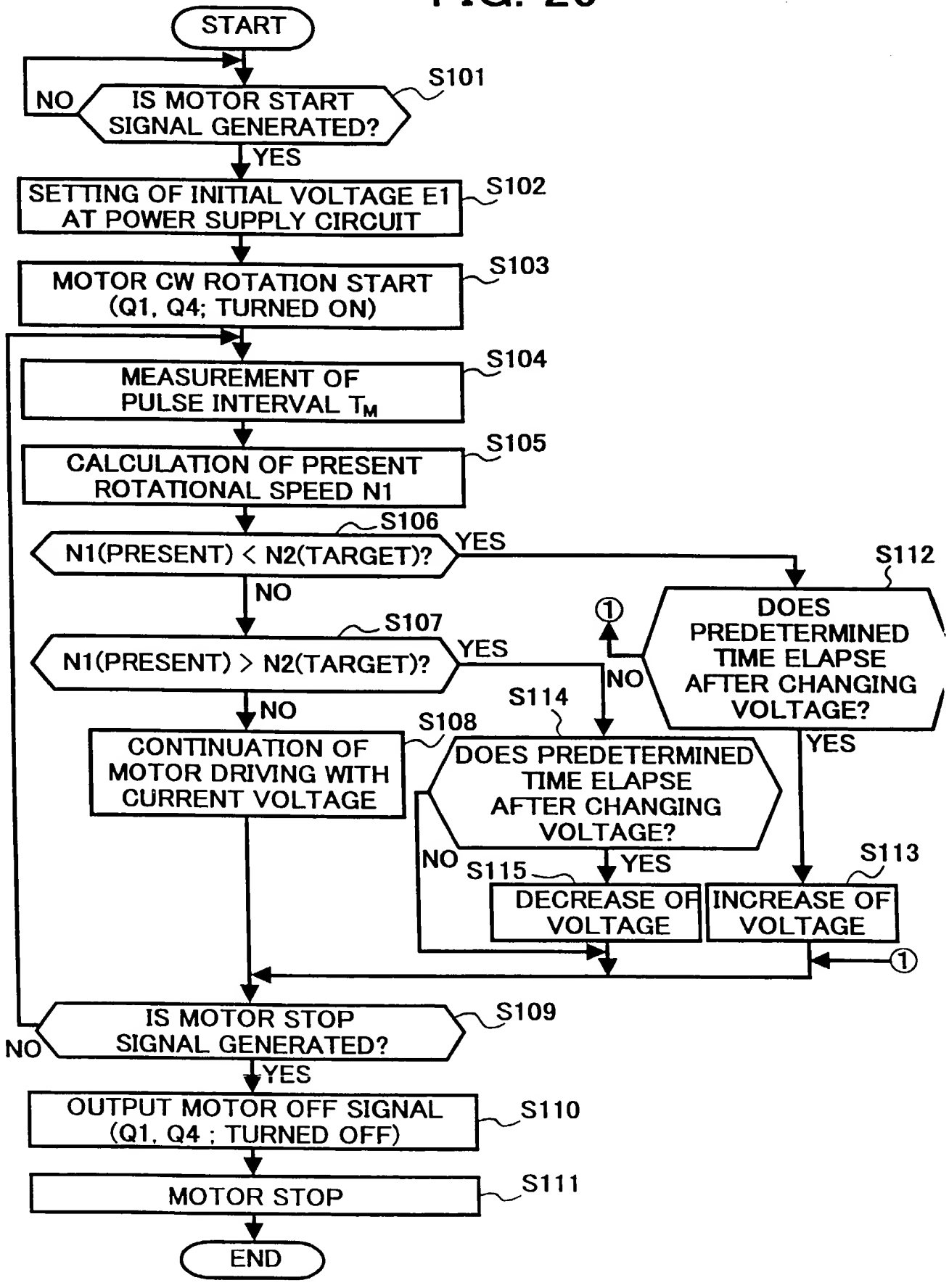

202
Q1
Q2
Q3
Q4
201
Q5
R11
R12
OPA
DAC
REFERENCE VOLTAGE D/A CONVERTOR
MOTOR CONTROL CIRCUIT
20
E

FIG. 26


START
S101
NO
IS MOTOR START SIGNAL GENERATED?
YES
SETTING OF INITIAL VOLTAGE E1 AT POWER SUPPLY CIRCUIT
S102
MOTOR CW ROTATION START (Q1, Q4; TURNED ON)
S103
MEASUREMENT OF PULSE INTERVAL T_M
S104
CALCULATION OF PRESENT ROTATIONAL SPEED N1
S105
S106
N1(PRESENT) < N2(TARGET)?
YES
S112
NO
S107
N1(PRESENT) > N2(TARGET)?
YES
①
DOES PREDETERMINED TIME ELAPSE AFTER CHANGING VOLTAGE?
NO
S114
NO
S108
CONTINUATION OF MOTOR DRIVING WITH CURRENT VOLTAGE
DOES PREDETERMINED TIME ELAPSE AFTER CHANGING VOLTAGE?
YES
NO
S115
YES
S113
DECREASE OF VOLTAGE
INCREASE OF VOLTAGE
①
S109
IS MOTOR STOP SIGNAL GENERATED?
NO
YES
OUTPUT MOTOR OFF SIGNAL (Q1, Q4 ; TURNED OFF)
S110
MOTOR STOP
S111
END

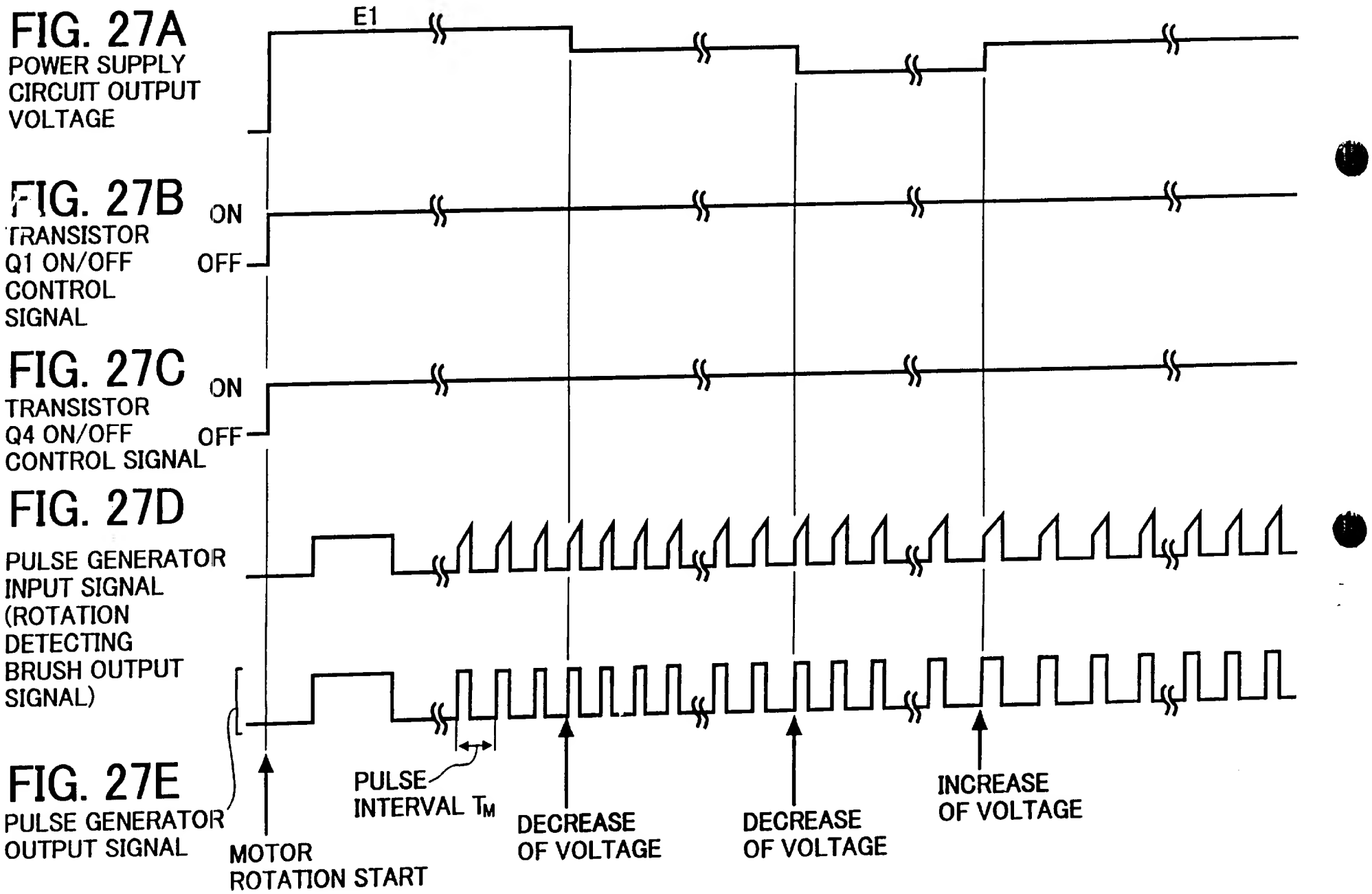


FIG. 27A
POWER SUPPLY CIRCUIT OUTPUT VOLTAGE
E1
FIG. 27B
TRANSISTOR Q1 ON/OFF CONTROL SIGNAL
ON
OFF
FIG. 27C
TRANSISTOR Q4 ON/OFF CONTROL SIGNAL
ON
OFF
FIG. 27D
PULSE GENERATOR INPUT SIGNAL (ROTATION DETECTING BRUSH OUTPUT SIGNAL)
FIG. 27E
PULSE GENERATOR OUTPUT SIGNAL
MOTOR ROTATION START
PULSE INTERVAL T_M
DECREASE OF VOLTAGE
DECREASE OF VOLTAGE
INCREASE OF VOLTAGE

FIG. 28

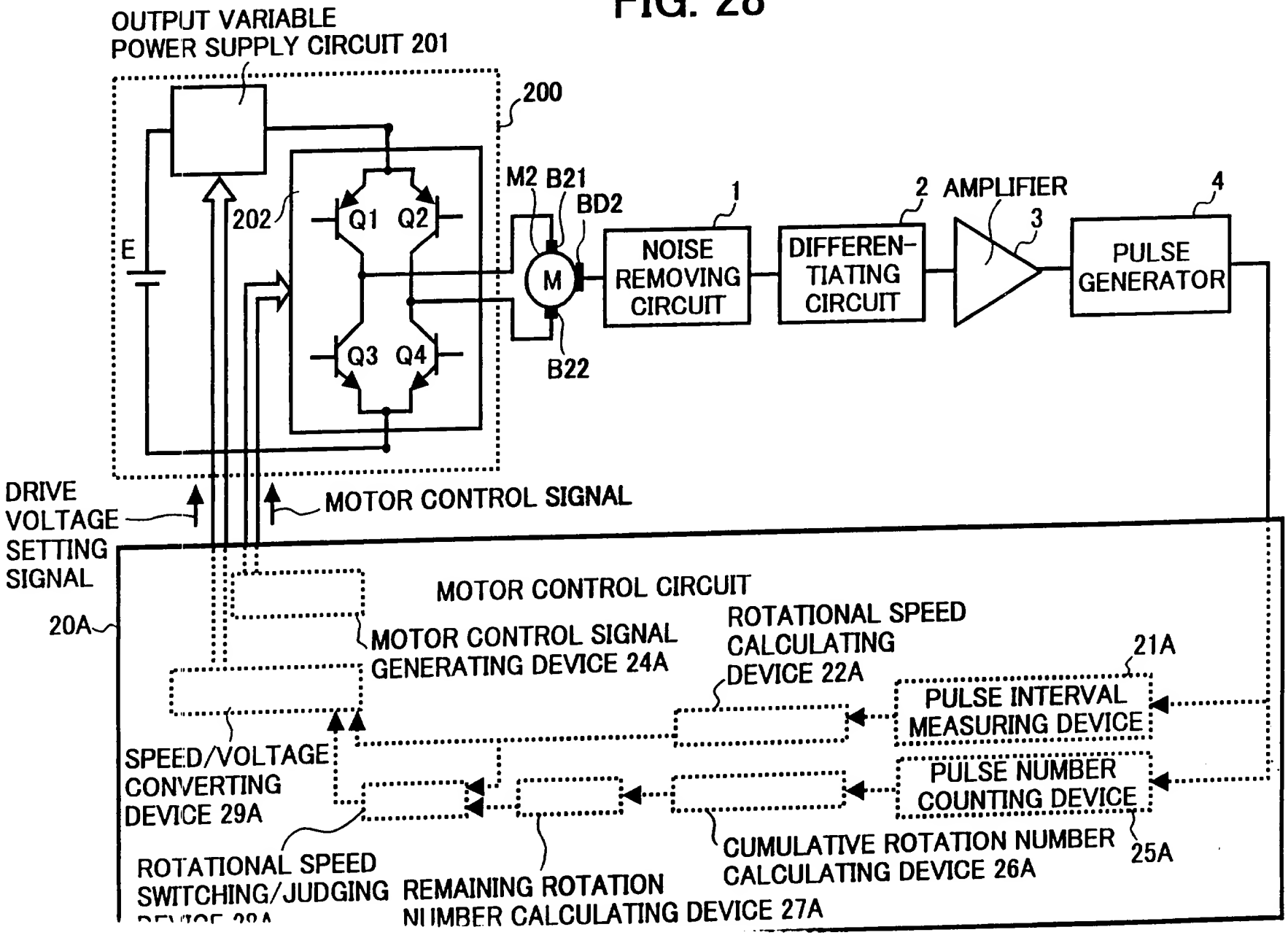

OUTPUT VARIABLE
POWER SUPPLY CIRCUIT 201
200
202
E
Q1
Q2
Q3
Q4
M2
B21
BD2
M
B22
1
NOISE
REMOVING
CIRCUIT
2
DIFFEREN-
TIATING
CIRCUIT
AMPLIFIER
3
4
PULSE
GENERATOR
DRIVE
VOLTAGE
SETTING
SIGNAL
MOTOR CONTROL SIGNAL
20A
MOTOR CONTROL CIRCUIT
MOTOR CONTROL SIGNAL
GENERATING DEVICE 24A
ROTATIONAL SPEED
CALCULATING
DEVICE 22A
21A
PULSE INTERVAL
MEASURING DEVICE
SPEED/VOLTAGE
CONVERTING
DEVICE 29A
PULSE NUMBER
COUNTING DEVICE
25A
ROTATIONAL SPEED
SWITCHING/JUDGING
DEVICE 28A
REMAINING ROTATION
NUMBER CALCULATING DEVICE 27A
CUMULATIVE ROTATION NUMBER
CALCULATING DEVICE 26A

FIG. 29A

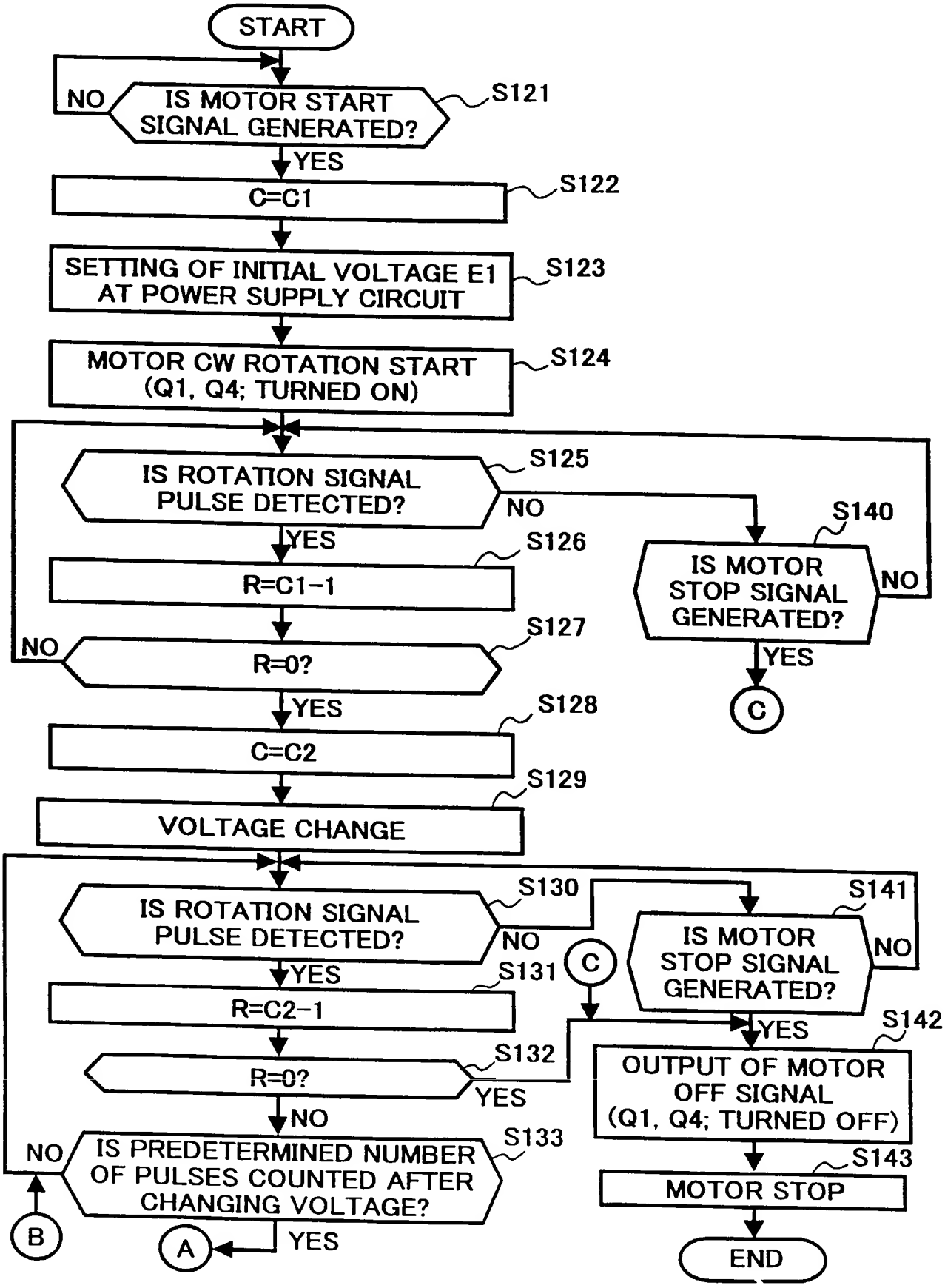
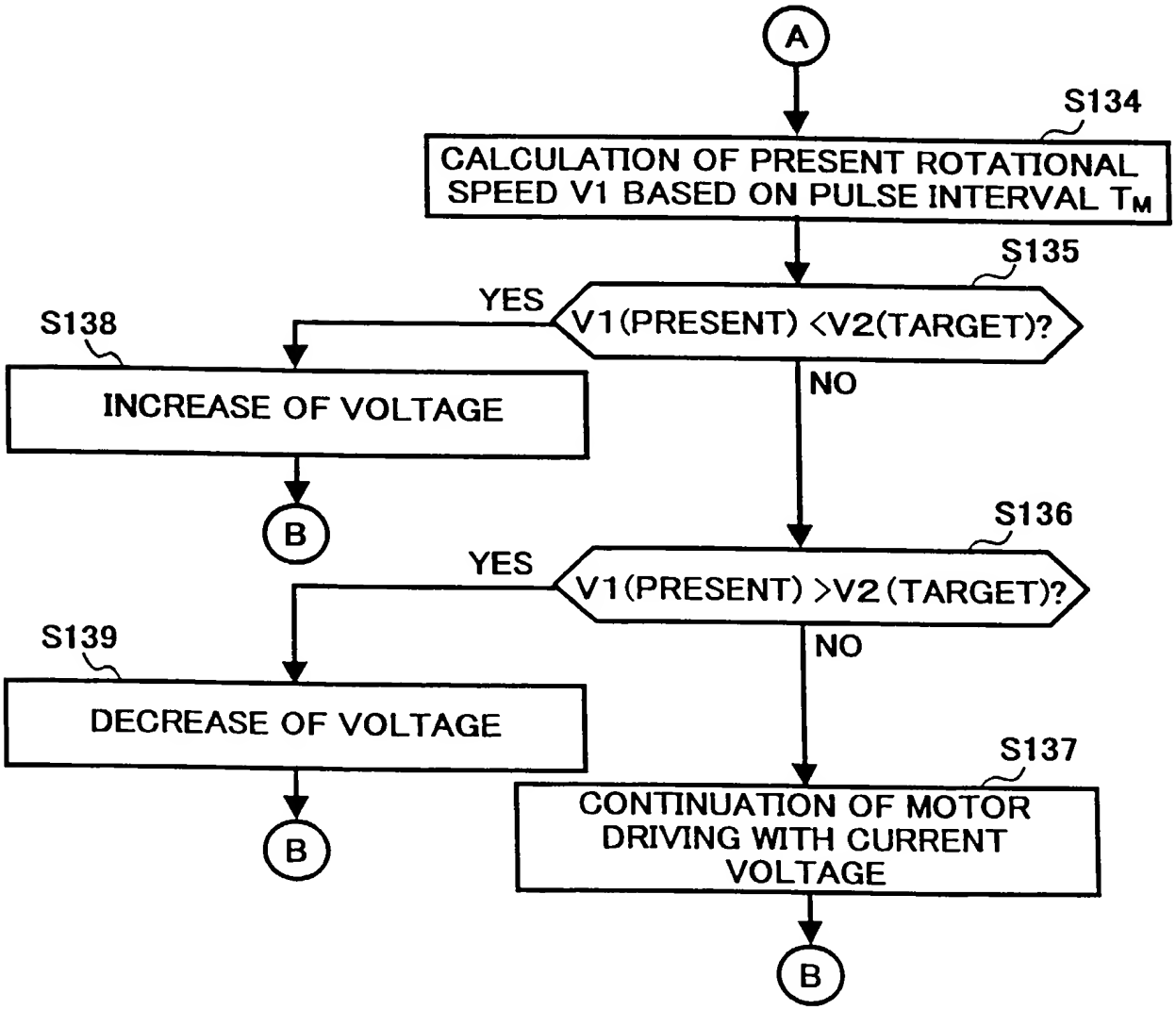

START
IS MOTOR START SIGNAL GENERATED?
NO
YES
S121
C=C1
S122
SETTING OF INITIAL VOLTAGE E1 AT POWER SUPPLY CIRCUIT
S123
MOTOR CW ROTATION START (Q1, Q4; TURNED ON)
S124
IS ROTATION SIGNAL PULSE DETECTED?
S125
NO
YES
R=C1-1
S126
R=0?
S127
NO
YES
C=C2
S128
VOLTAGE CHANGE
S129
IS ROTATION SIGNAL PULSE DETECTED?
S130
NO
YES
R=C2-1
S131
R=0?
S132
YES
NO
IS PREDETERMINED NUMBER OF PULSES COUNTED AFTER CHANGING VOLTAGE?
S133
NO
YES
A
B
IS MOTOR STOP SIGNAL GENERATED?
S140
NO
YES
C
IS MOTOR STOP SIGNAL GENERATED?
S141
NO
C
YES
OUTPUT OF MOTOR OFF SIGNAL (Q1, Q4; TURNED OFF)
S142
MOTOR STOP
S143
END

FIG. 29B


A
S134
CALCULATION OF PRESENT ROTATIONAL SPEED V1 BASED ON PULSE INTERVAL TM
S135
YES
V1(PRESENT) <V2(TARGET)?
S138
INCREASE OF VOLTAGE
B
NO
S136
YES
V1(PRESENT) >V2 (TARGET)?
S139
DECREASE OF VOLTAGE
B
NO
S137
CONTINUATION OF MOTOR DRIVING WITH CURRENT VOLTAGE
B

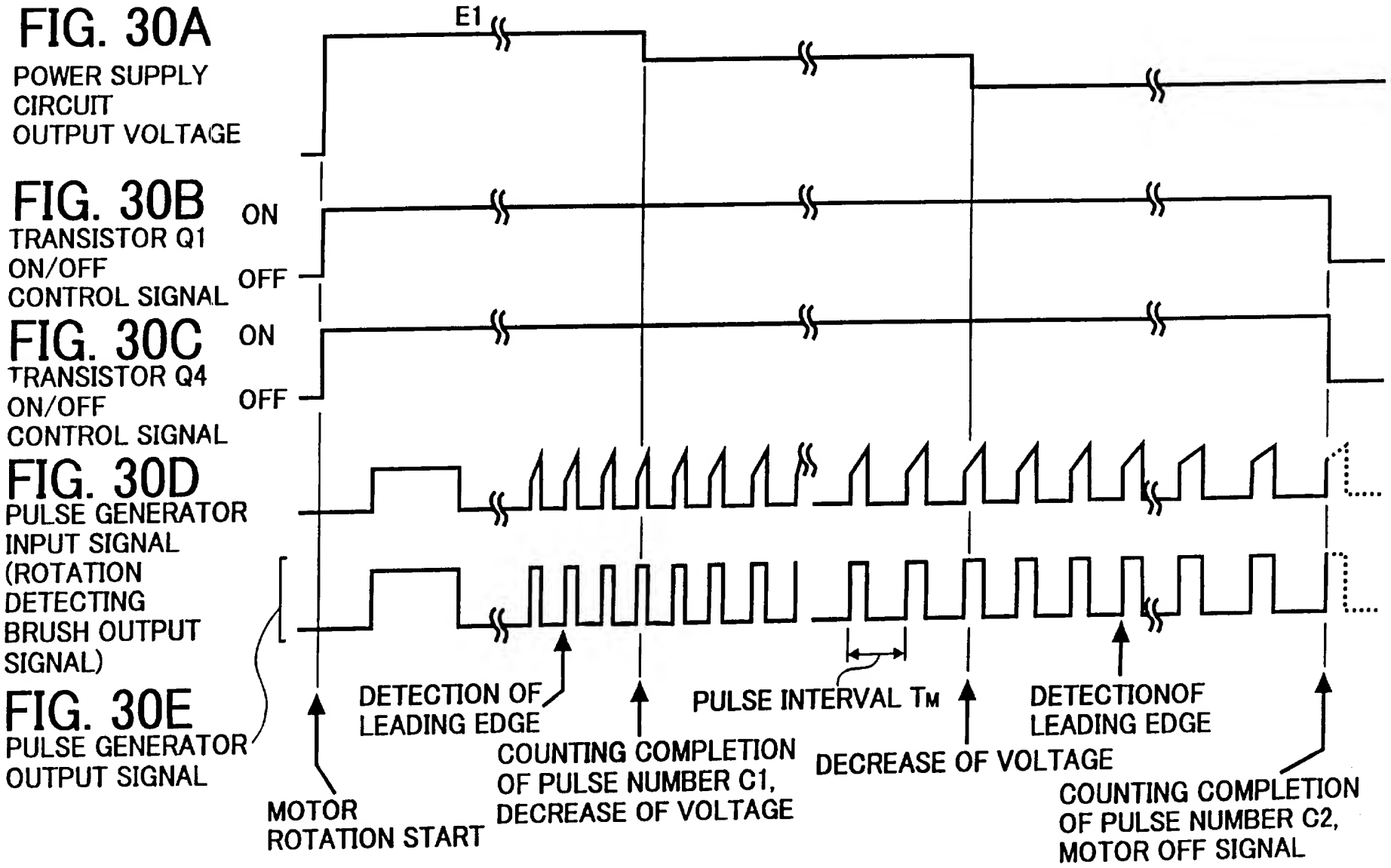


FIG. 30A
POWER SUPPLY CIRCUIT OUTPUT VOLTAGE
E1
FIG. 30B
TRANSISTOR Q1 ON/OFF CONTROL SIGNAL
ON
OFF
FIG. 30C
TRANSISTOR Q4 ON/OFF CONTROL SIGNAL
ON
OFF
FIG. 30D
PULSE GENERATOR INPUT SIGNAL (ROTATION DETECTING BRUSH OUTPUT SIGNAL)
FIG. 30E
PULSE GENERATOR OUTPUT SIGNAL
MOTOR ROTATION START
DETECTION OF LEADING EDGE
COUNTING COMPLETION OF PULSE NUMBER C1, DECREASE OF VOLTAGE
PULSE INTERVAL TM
DECREASE OF VOLTAGE
DETECTIONOF LEADING EDGE
COUNTING COMPLETION OF PULSE NUMBER C2, MOTOR OFF SIGNAL

FIG. 31A

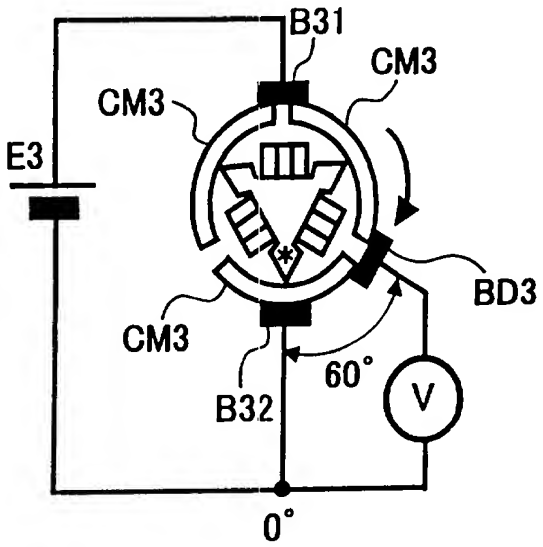


FIG. 31B

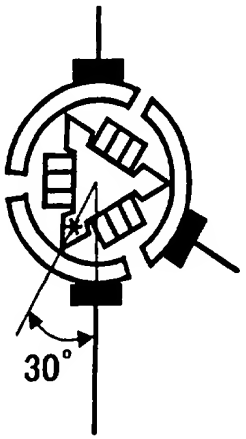


FIG. 31C

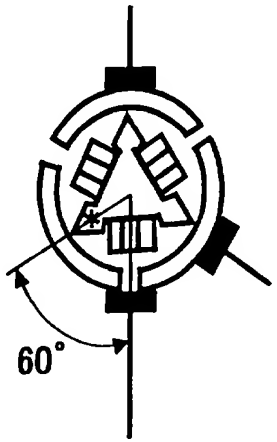


FIG. 31D

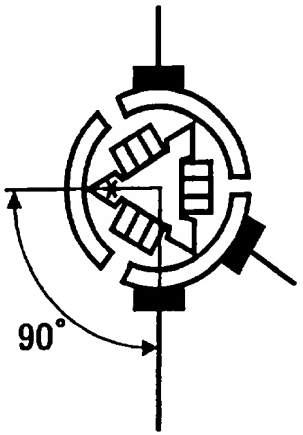


FIG. 31E

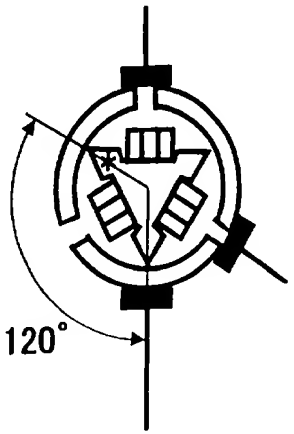


FIG. 32

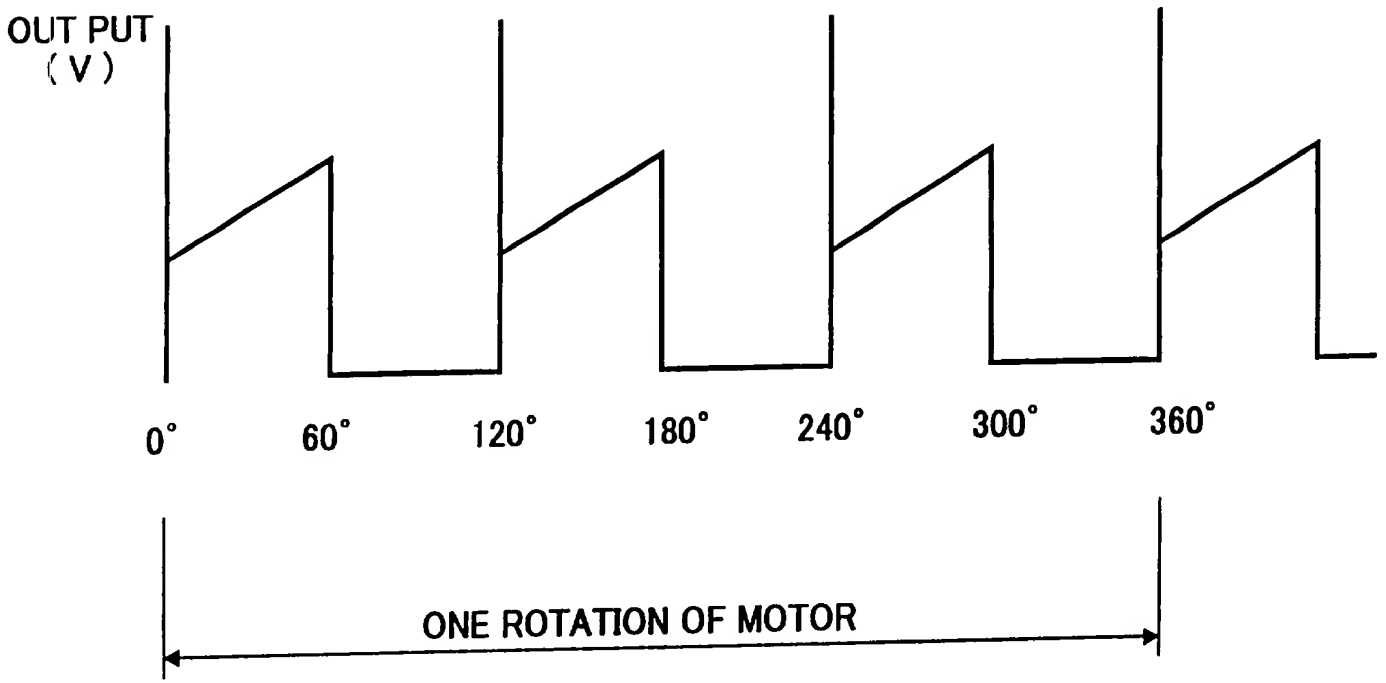


FIG. 33A

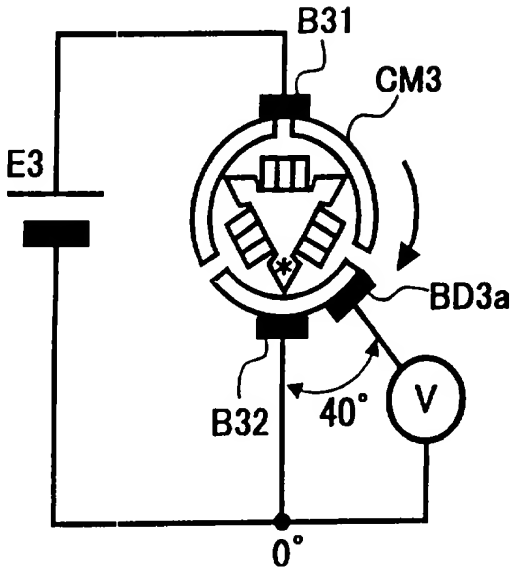


FIG. 33B

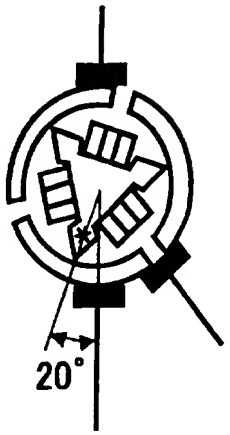


FIG. 33C

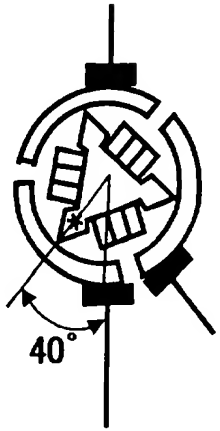


FIG. 33D

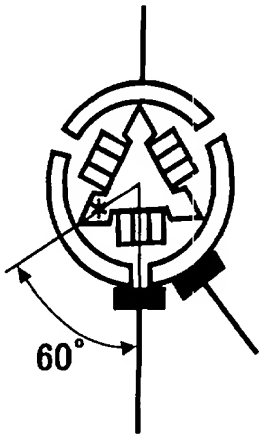


FIG. 33E

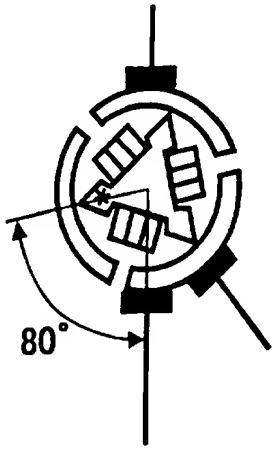


FIG. 33F

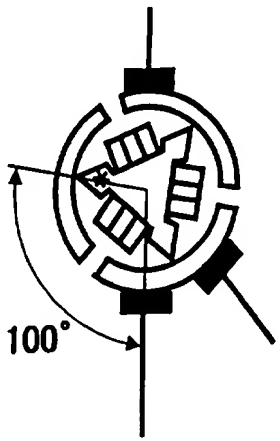


FIG. 33G

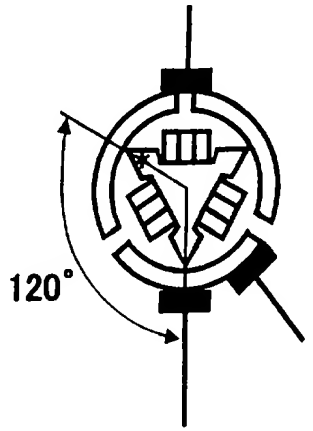


FIG. 34

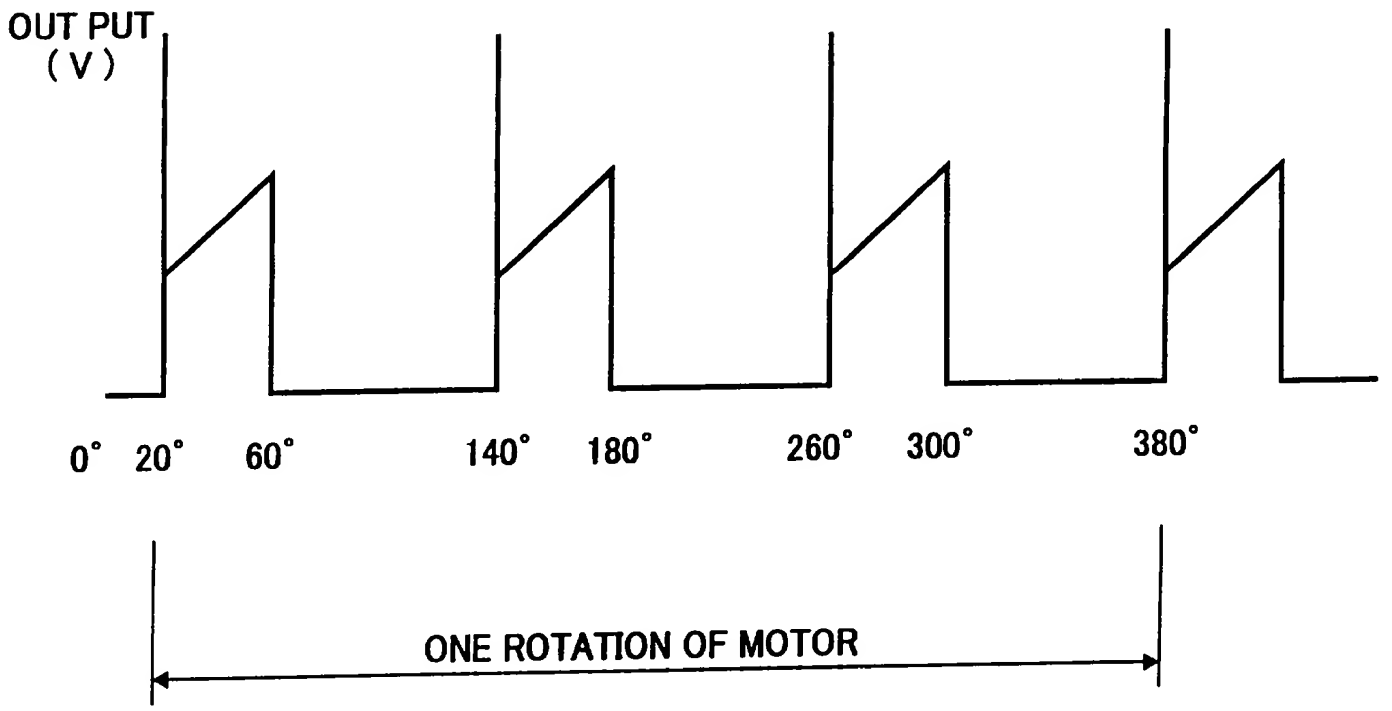


FIG. 35
BACKGROUND ART

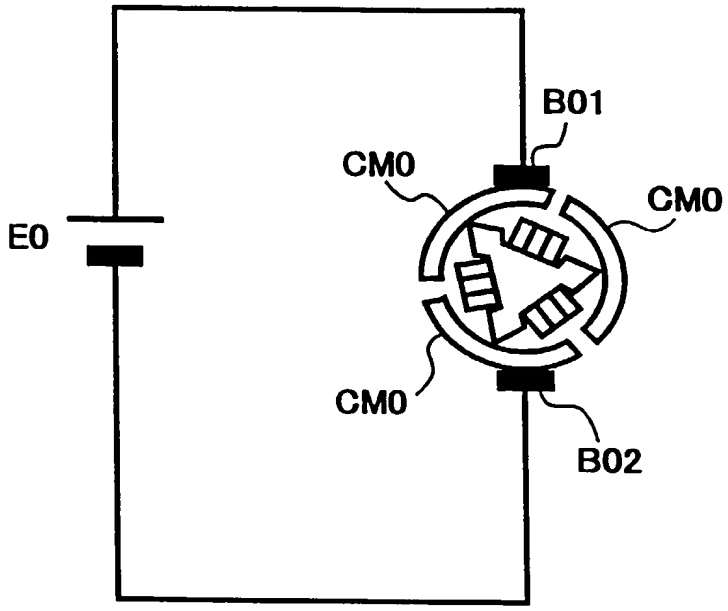


FIG. 36
BACKGROUND ART

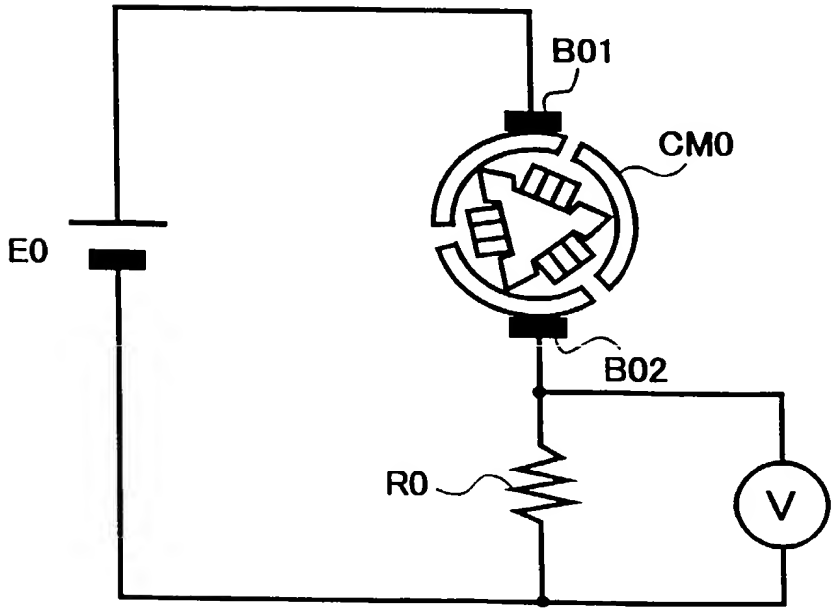


FIG. 37

BACKGROUND ART

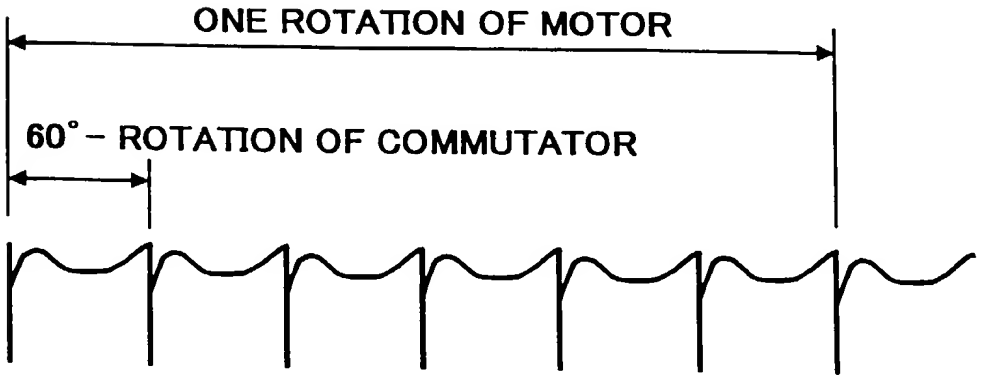


FIG. 38

BACKGROUND ART

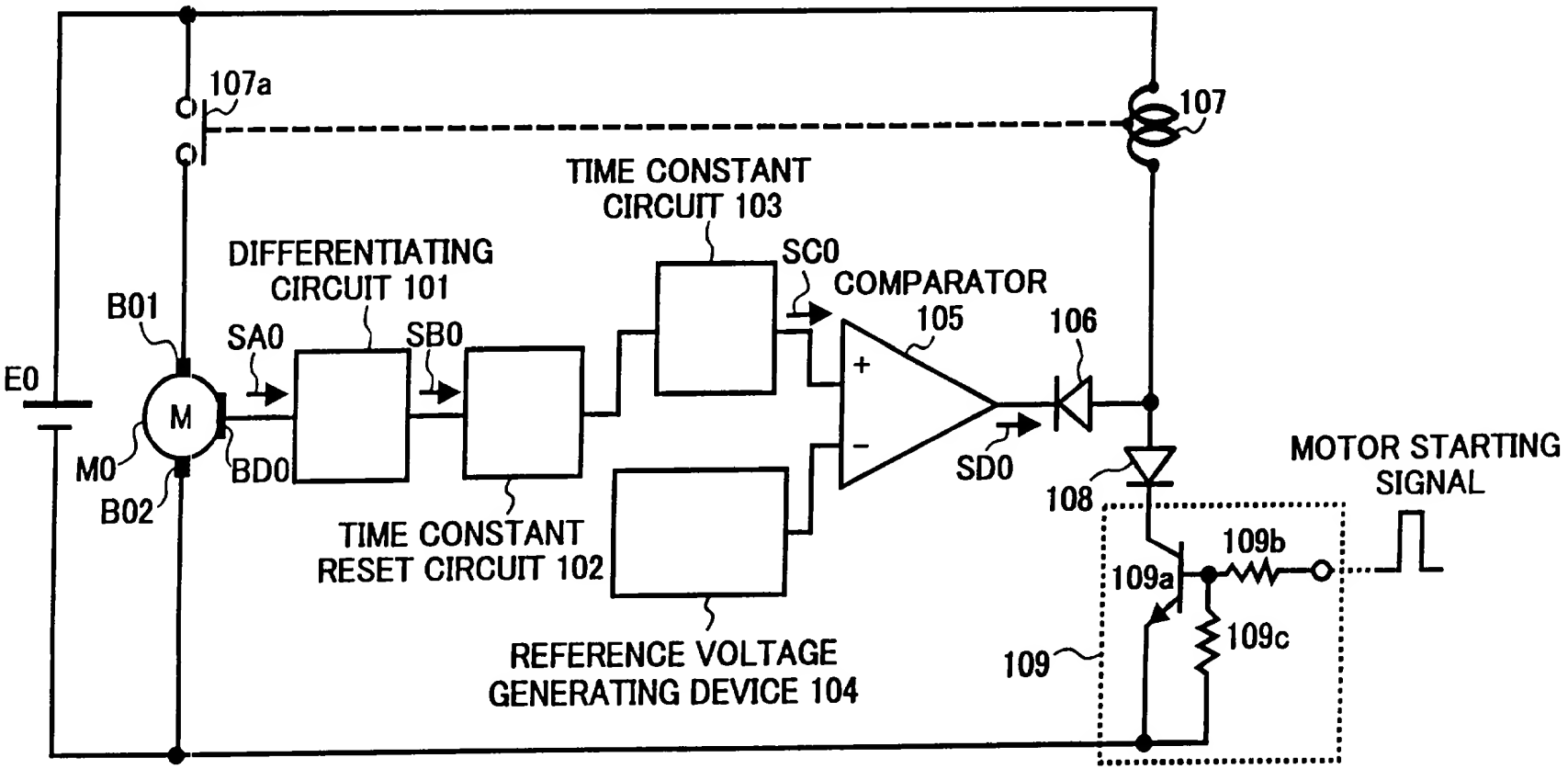


FIG. 39
BACKGROUND ART